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NATIONAL DAM SAFETY PROGRAM. LAWLESS LAKE DAM (MO 31717), MISSI--ETC(U)

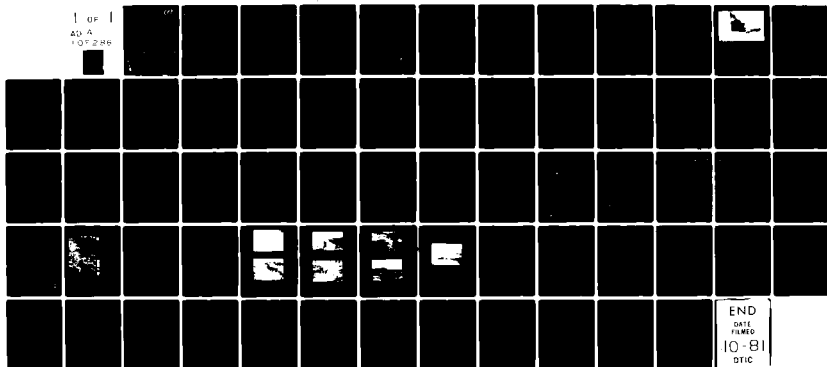
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**LAWLESS LAKE DAM
IRON COUNTY, MISSOURI
MO 31717**



**PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION**



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7. AUTHOR(s) Woodward-Clyde Consultants		6. PERFORMING ORG. REPORT NUMBER	
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.			

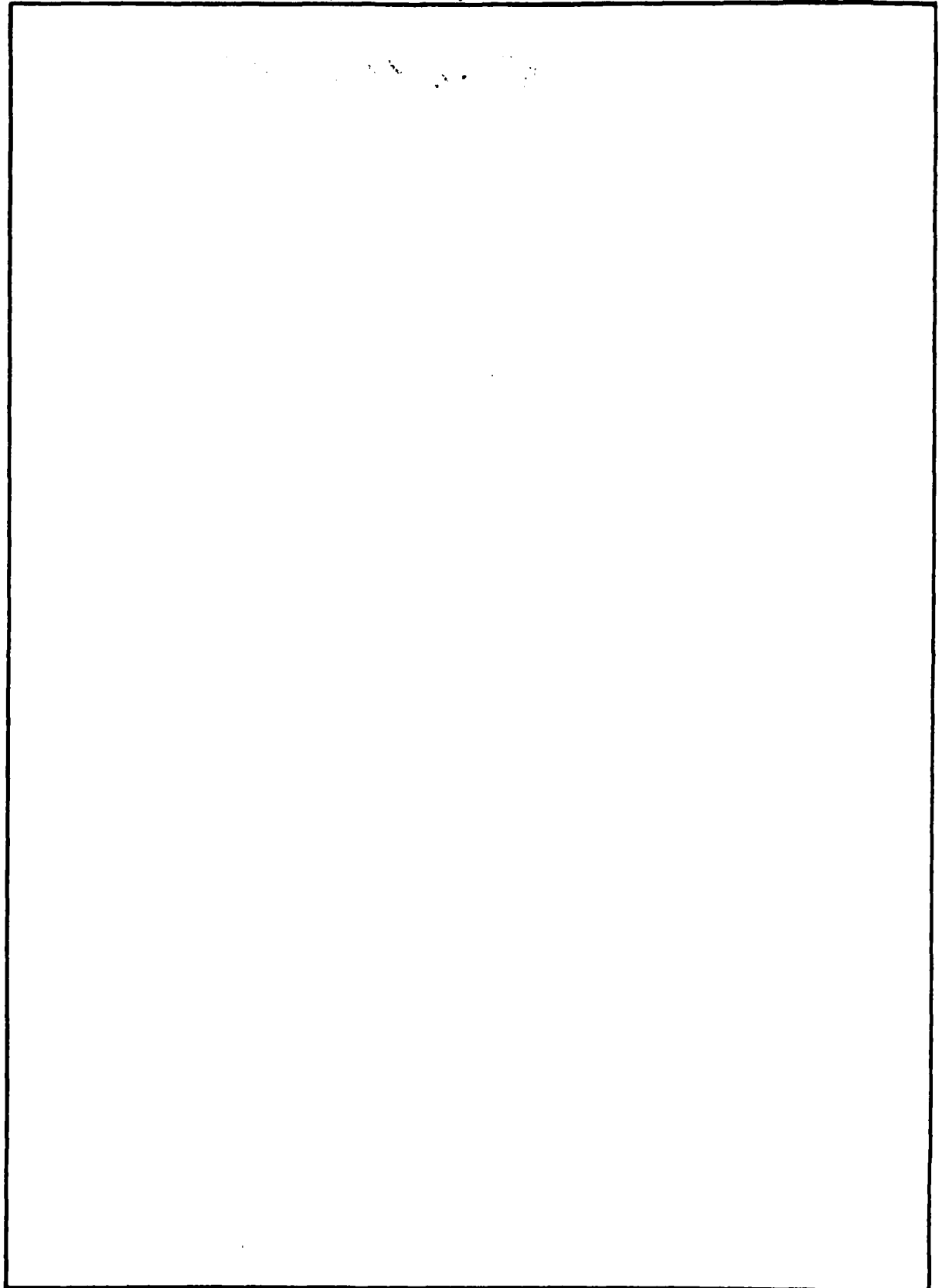
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ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

SUBJECT: Lawless Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lawless Lake Dam (MO 31717).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St Louis District as a result of the application of the following criteria:

- a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.
- b. Overtopping of the dam could result in failure of the dam.
- c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY:

SIGNED

Chief, Engineering Division

21 JUL 1981

Date

APPROVED BY:

SIGNED

Colonel, CE, Commanding

21 JUL 1981

Date

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LAWLESS LAKE DAM
Iron County, Missouri
Missouri Inventory No. 31717

Phase I Inspection Report
National Dam Safety Program

Prepared by

Woodward-Clyde Consultants
Chicago, Illinois

Under Direction of
St Louis District, Corps of Engineers

for
Governor of Missouri
June 1981

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of the Chief of Engineers, Washington, D. C., 20314. The purpose of a Phase I investigation is not to provide a complete evaluation of the safety of the structure nor to provide a guarantee on its future integrity. Rather the purpose of the program is to identify potentially hazardous conditions to the extent they can be identified by a visual examination. The assessment of the general condition of the dam is based upon available data (if any) and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify the need for more detailed studies. In view of the limited nature of the Phase I studies no assurance can be given that all deficiencies have been identified.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with any data which may be available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action removes the normal load on the structure, as well as the reservoir head along with seepage pressures, and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected, so that corrective action can be taken. Likewise continued care and maintenance are necessary to minimize the possibility of development of unsafe conditions.

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lawless Lake Dam
State Located	Missouri
County Located	Iron
Stream	Unnamed Tributary of Big Creek
Date of Inspection	27 April 1981

Lawless Lake Dam, Missouri Inventory Number 31717, was inspected by Richard Berggreen (engineering geologist), Jean-Yves Perez (geotechnical engineer), Maryann Rivera (hydrologist) and Craig Fulthorpe (geotechnical engineer).

The dam inspection was made following the guidelines presented in the "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed by the Chief of Engineers, US Army, Washington, DC, with the help of federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines represent a consensus of the engineering profession. The safety inspections are intended to provide for an expeditious identification based on available data and a visual inspection, of those dams which may pose hazards to human life and property. In view of the limited nature of the study, no assurance can be given that all deficiencies have been identified.

The St Louis District (SLD), Corps of Engineers has classified this dam as having a high hazard potential. The estimated damage zone length, as determined by the SLD, extends approximately one mile downstream. Within the damage zone are several occupied dwellings, a road and a railroad. The contents of the downstream hazard zone were verified by aerial reconnaissance.

The dam is classified as small due to its 27.5 ft height and 48 ac-ft storage volume. The small dam classification includes dams having a storage volume between 50 and 1000 ac-ft, or a height between 25 and 40 ft.

Our inspection and evaluation indicate the embankment is in generally good condition. The reservoir was nearly empty at the time of the inspection because it had been drained for repair work and there has been insufficient precipitation to fill the

reservoir since then. No evidence was found of significant erosion, slope instability, disruption of the vertical or horizontal alignment of the dam, or detrimental vegetation. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

Hydrologic/hydraulic analyses indicate that a 1 percent probability-of-occurrence event (100-year flood) will not result in overtopping of the dam. These analyses also indicate that the dam will be overtopped by a flood event which produces greater than 14 percent of the Probable Maximum Flood (PMF). The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines recommend a spillway design flood between 50 and 100 percent of the PMF for small size dams. On the basis of the broad downstream valley, 50 percent of the PMF is recommended as the spillway design flood for this dam.

The following specific remedial measures and additional studies are recommended for this dam, to be undertaken without undue delay.

1. Prepare a more detailed hydraulic/hydrologic study and design a spillway system capable of passing at least 50 percent of the PMF without overtopping the dam. This design study should include an evaluation of the risk of embankment erosion for storms greater than 50 percent of the PMF. The spillway system should be protected to prevent erosion.
2. Deepen or raise the sides of the main and auxiliary spillway discharge channels to direct flow away from the toe of the dam. The need for lining the channels should be considered.
3. Provide a trash rack for the 24-in. diameter main spillway pipe and provide erosion protection to the embankment at the inlet to the pipe.

The following measures should be taken as soon as practical.

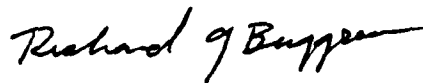
4. Prepare seepage and stability analyses for the dam in accordance with the "Recommended Guidelines for Safety Inspection of Dams."

5. Remove small trees from the embankment before they become large enough to pose a potential hazard to the dam.
6. Provide adequate grass cover for erosion protection on the upper part of the downstream slope.
7. Evaluate the feasibility of an effective and practical warning system to alert downstream residents, should potentially hazardous conditions develop at the dam.
8. Initiate a program of periodic inspections to identify signs of pore pressure build-up along the downstream toe, slope instability, seepage, turbidity (soil) in the seepage water (particular attention being paid to the spring noted at the time of the first filling of the reservoir), or erosion and recommended necessary maintenance. These recommended periodic inspections will become more meaningful as the reservoir level rises in the future and is maintained at its design level.

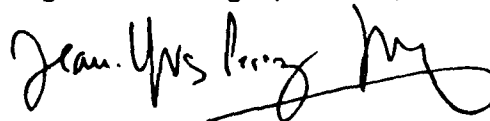
The recommended analyses and remedial work should be performed by or under the guidance of an engineer experienced in the design and construction of earth dams.

It is recommended the owner take action on these recommendations as soon as practical to prevent the development of hazardous conditions at the dam. The recommendations concerning the spillway should be implemented without undue delay.

WOODWARD-CLYDE CONSULTANTS



Richard G. Berggreen
Registered Geologist, No 3572, CA



Jean-Yves Perez, PE No. 62-34675, IL
Vice President



OVERVIEW
LAWLESS LAKE DAM

MISSOURI INVENTORY NUMBER MO 31717

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAWLESS LAKE DAM
MISSOURI INVENTORY NO. 31717

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2.	Drainage Basin and Site Topography
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3-B.	Dam and Spillway Cross Sections
4.	Regional Geologic Map

APPENDICES

A	Figure A-1: Photo Location Sketch
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Photographs

1. Downstream hazard zone, looking east. Reservoir is visible near center of top edge of photo.
2. Downstream slope, looking north. Note sparsely vegetated upper slope.
3. Dam crest, looking north.
4. Inlet to 24-in. diameter main spillway pipe. Note partial blockage by vegetation.
5. Auxiliary spillway, looking northeast. Note fish control fence and erosion gully leading into reservoir.
6. Reservoir area, looking northeast. Note low water level and near vertical cut slopes. Also note erosion gully from left abutment into reservoir (bottom of photo).
7. Spillway discharge channels, looking west (downstream). The main spillway discharges to the right of the low ridge in the foreground, the auxiliary spillway to the left.

B	Hydraulic/Hydrologic Data and Analyses
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**PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAWLESS LAKE DAM - MISSOURI INVENTORY NO. 31717**

**SECTION I
PROJECT INFORMATION**

1.1 General

- a. **Authority.** The National Dam Inspection Act, Public Law 92-367, provides for a national inventory and inspection of dams throughout the United States. Pursuant to the above, an inspection was conducted of Lawless Lake Dam, Missouri Inventory Number 31717.
- b. **Purpose of Inspection.** "The primary purpose of the Phase I investigation program is to identify expeditiously those dams which may pose hazards to human life or property... The Phase I investigation will develop an assessment of the general condition with respect to safety of the project based upon available data and a visual inspection, determine any need for emergency measures, and conclude if additional studies, investigations and analyses are necessary and warranted" (Chapter 3, "Recommended Guidelines for Safety Inspection of Dams").
- c. **Evaluation criteria.** The criteria used to evaluate the dam were established in the "Recommended Guidelines for Safety Inspection of Dams," and Engineering Regulation No. 1110-2-106 and Engineering Circular No. 1110-2-188, "Engineering and Design National Program for Inspection of Non-Federal Dams," developed by the Office of Chief of Engineers, Department of the Army; and "Hydrologic/Hydraulic Standards Phase I Safety Inspection of Non-Federal Dams," prepared by the St Louis District (SLD), Corps of Engineers. These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 Description of Project

- a. Description of dam and appurtenances. The dam is an earth dam, constructed of weathered rock and soil from the vicinity of the dam, impounding a lake for recreational purposes. When the reservoir was first filled the owner noticed a loss of water and drained the lake to perform repairs. The reservoir was still nearly empty at the time of the visual inspection. The spillways are at the left abutment of the dam (as the observer faces downstream). The main spillway is a 24-in. diameter corrugated steel pipe passing through the embankment near the left abutment. The auxiliary spillway is an uncontrolled, unlined, irregularly-shaped open channel in the left abutment.
- b. Location. The dam is located on an unnamed tributary of Big Creek, about 0.6 mi east of Sabula, Iron County, Missouri (Fig. 1). The dam is in Section 2, T31N, R2E, on the USGS Glover, Missouri 7.5-minute quadrangle map (1968).
- c. Size classification. The dam is classified small based on its height of 27.5 ft and storage capacity of 48 ac-ft. Guidelines criteria for the small dam classification are: height between 25 and 40 ft, or storage capacity between 50 and 1000 ac-ft.
- d. Hazard classification. The St Louis District (SLD), Corps of Engineers has classified this dam as having a high hazard potential; we concur with this classification. The SLD estimated damage zone length extends approximately 1 mi downstream of the dam. Within this zone are several occupied dwellings, assorted farm buildings, a road and a railroad (Photo 1). The contents of the downstream hazard zone were verified by aerial reconnaissance.
- e. Ownership. We understand the dam is owned by Mr David J. Lawless, 294 Fourth Avenue South, Naples, Florida 33940.
- f. Purpose of dam. The dam was constructed to impound a lake for recreational purposes.

- g. Design and construction history. The owner of the dam, Mr David J. Lawless, stated in a phone interview that he was an engineer and had designed and constructed the dam himself. The dam was constructed during the period 1977-1978. Mr Lawless said that the flow in a spring downstream of the dam increased when the reservoir was first filled. By using dye tracing, he determined that the water in the spring was coming from the reservoir and hypothesized the existence of a solution feature in the bedrock. He reported that the lake was emptied using a siphon and that an 18 ft deep trench was dug at the toe of the downstream slope and backfilled with compacted clay to cutoff flow in the solution feature. In addition, the lake bed was lined with clay. The reservoir has not since been full due to a lack of precipitation.

No other records of the design and construction were available.

- h. Normal operating procedures. No operating records were available for this dam. The pool elevation is controlled by the elevation of the ungated spillway.

1.3 Pertinent Data

a. <u>Drainage area.</u>	0.09 mi ²
b. <u>Discharge at damsite.</u>	
Maximum known flood at damsite	Unknown
Warm water outlet at pool elevation	N/A (Not applicable)
Diversion tunnel low pool outlet at pool elevation	N/A
Diversion tunnel outlet at pool elevation	N/A
Gated spillway capacity at pool elevation	N/A
Gated spillway capacity at maximum pool elevation	N/A
Ungated spillway capacity at maximum pool elevation	100 ft ³ /sec*
Total spillway capacity at maximum pool elevation	100 ft ³ /sec*

*Includes both main and auxiliary spillway capacities.

c. Elevation (ft above MSL).

Top of dam	Varies from 798.9 to 800.5
Maximum pool-design surcharge	N/A
Full flood control pool	N/A
Recreation pool (main spillway crest)	795.9
Spillway crest (gated)	N/A
Upstream portal invert diversion tunnel	N/A
Downstream portal invert diversion tunnel	N/A
Streambed at centerline of dam	Unknown
Maximum tailwater	Unknown
Toe of dam at maximum section	771.6

d. Reservoir.

Length of maximum pool	900 ft
Length of recreation pool	860 ft
Length of flood control pool	N/A

e. Storage (acre-feet).

Recreation pool (main spillway crest)	40
Flood control pool	N/A
Design surcharge	N/A
Top of dam	48

f. Reservoir Surface (acres).

Top of dam	2.8
Maximum pool	2.8
Flood control pool	N/A
Recreation pool	2.5
Spillway crest (main spillway)	2.5

g. Dam.

Type	Earth fill
Length	292 ft
Height	27.5 ft
Top width	Varies from 10 ft to 16 ft
Side slopes	Upstream 3.0 - 3.8(H) to 1(V) increasing to 1.7 - 2.3(H) to 1(V) near the crest. Downstream 2.0 - 2.5(H) to 1(V)
Zoning	Unknown
Impervious core	Homogeneous impermeable embankment.
Cutoff	18 ft deep trench at downstream toe.
Grout curtain	None

h. Diversion and regulating tunnel.

Type	None
Length	N/A
Closure	N/A
Access	N/A
Regulating Facilities	N/A

i. Spillway.

<u>Main:</u> Type	24-in. diameter corrugated steel pipe
Length of pipe	33 ft
Inlet invert elevation	795.9 ft (MSL)
Gates	None
Downstream channel	Unlined, earth

Auxiliary:
Type

Length of weir	Uncontrolled, unlined open channel, irregular shape with a low point in a narrow V-notch at EL 796.9 ft (MSL). Equipped with fish control fence.
Crest elevation	Open channel, 45 ft wide at EL 798.9 ft (MSL), minimum top of dam
Gates	796.9 ft (MSL)
Downstream channel	None
	Unlined earth

j. Regulating outlets.

None.

SECTION 2 ENGINEERING DATA

2.1 Design

All design information was obtained during phone interviews with the owner of the dam, Mr David J. Lawless, who stated that he designed the dam himself. No design drawings or other documents were available.

2.2 Construction

All information on the construction of the dam was obtained during phone interviews with Mr Lawless. No other construction records were available.

Mr Lawless stated that he constructed the dam himself during the period 1977-1978. He reported that, on the first filling of the reservoir, a solution feature in the bedrock appeared to be transmitting water from the reservoir to a spring downstream of the dam. The existence of a solution feature was hypothesized when dye put into the reservoir appeared in the spring. The reservoir was then emptied using a siphon. A trench 18 ft deep was cut at the toe of the downstream slope and backfilled with compacted clay in order to cutoff flow in the solution feature. In addition, the lake bed was lined with clay. The reservoir has not been full since due to lack of precipitation and it is, therefore, not possible to assess the effectiveness of these measures. Since the reservoir has been empty for some time, the clay liner is likely to be dessicated and may not be effective. However, if the downstream cutoff is effective, high pore pressures could develop under the downstream slope. This could result in slope failure on the downstream slope of the embankment.

2.3 Operation

No records were available concerning regulation of the pool elevation. Normal pool elevation is controlled by flow through the ungated spillway. At the time of the visual inspection, the reservoir was practically empty. There was no evidence or record of the dam being overtopped. However, a high water mark was surveyed at EL 796.9 ft (MSL). This would have resulted in flow through the main spillway.

2.4 Evaluation

- a. Availability. No data were available regarding engineering or design of this dam, other than the information obtained in the phone interviews with the owner.
- b. Adequacy. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These analyses should be performed by a professional engineer experienced in the design and construction of earth dams. These analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

No records are available of any strength data on the soils used in construction of the dam, or any compaction tests made during construction. Consequently, the adequacy of the embankment design cannot be assessed. Our comments concerning the adequacy of the spillway are discussed in Section 5 of this report.

- c. Validity. There is no reason to question the validity of the information supplied by the owner. The information was not in conflict with the conditions observed during our inspections, except that it was not possible to determine the location of the cutoff trench due to the growth of grass over the downstream toe. The available engineering information is incomplete.

2.5 Project Geology

The dam site is located on the southwestern flank of the Ozark structural dome. Bedrock in the area is mapped on the Geologic Map of Missouri (1979) as the Cambrian age Potosi Dolomite and Eminence Dolomite. The Potosi Dolomite, a light gray medium- to fine-grained dolomite, typically contains an abundance of quartz druse associated with chert deposits within the formation. The Eminence Dolomite, which conformably overlies the Potosi Dolomite, is similar in appearance but contains less chert and quartz.

The owner noted the presence of numerous springs and caves in the area. The problem of leakage beneath the dam, reported by the owner, indicates solutioning of the bedrock could be a continuing problem at this facility.

The soil in the area is a light brown, low plasticity, gravelly silt (ML). The Missouri General Soils Map (1979) indicates the dam site lies slightly north of the contact between two soil types. To the north of the contact is the Captina-Clarksville-Coulstone Soil Association; to the south is the Peridge-Cantwell-Gasconade Association.

The Structural Features Map of Missouri (1971) shows the closest incidence of faulting to the dam site to be the Glover Faults. These are two short (about 1 to 1.5 miles long) NE-SW trending faults located about 6 miles north of the dam site. Displacement on these faults is northwest side up. The Black Fault, a NW-SE trending fault approximately 16 miles long, is located about 7 miles northeast of the dam site. Displacement on the Black Fault is northeast side up.

Other small faults mapped in the area of the dam site include the Ketcherside Gap Fault, approximately 7.5 miles north, and the Hogan Mountain Faults, about 9 miles north. These faults, like most others in the Ozark region, are within Precambrian and Paleozoic formations, and are likely Paleozoic in age. They are not considered seismically active.

The dam is located approximately 80 miles northwest of the line of epicenters for the very large New Madrid earthquakes of 1811 and 1812. A recurrence of an earthquake of the magnitude of the New Madrid events could possibly cause damage at the dam, but a study of this aspect of risk was beyond the scope of this Phase I inspection.

SECTION 3

VISUAL INSPECTION

3.1 Findings

- a. General. A visual inspection of Lawless Lake Dam was made on 27 April 1980. The owner was not present for the inspection. The inspection indicated that the dam embankment is in generally good condition.
- b. Dam. The dam is an earth fill dam constructed with gravelly, low plasticity silty soil (ML), apparently excavated from the left abutment and probably also from the reservoir area. The gravelly silt appears to be a residual soil typically developed as a result of weathering of the carbonate bedrock in the area. The embankment material is considered to have a moderate to high susceptibility to erosion in the event of overtopping. No evidence or record of past overtopping was noted during the visual inspection.

The downstream face of the dam has a slope of 2 to 2.5(H): 1(V). The lower half of the downstream slope has a thick grass cover and may have been the location of the excavation for the cutoff trench. The upper half, however, is sparsely vegetated and has large bare patches (Photo 2). There are several small trees on the downstream slope. The upstream face has a slope of 3 to 3.8(H):1(V), increasing to 1.7 to 2.3(H):1(V) near the crest and is not vegetated. There is no riprap or other erosion protection on the upstream face.

The vertical and horizontal alignment of the dam crest appears undisrupted (Photo 3). There was no evidence of detrimental settlement, sinkhole development or animal burrows on the dam. Some minor gully erosion has occurred on the unvegetated upper part of the downstream slope. There was no evidence of any seepage through the dam. However, the reservoir was practically empty at the time of the visual inspection and the possibility that seepage

could develop, when the reservoir level is high, cannot be discounted. A spring was noted by the owner downstream of the dam when the reservoir was full. A cutoff trench was reportedly dug and the reservoir lined with clay but the effectiveness of these measures could not be assessed at the time of the inspection. Since the reservoir has been empty for some time, the clay liner placed on the floor of the reservoir is likely to be dessicated and may not be effective. However, if the downstream cutoff is effective, high pore pressures could develop under the downstream slope. This could result in failure of the dam. The location of the cutoff could not be determined during the inspection.

c. Appurtenant structures.

1. Spillway. The spillways for this dam are located at the left abutment. The main spillway is a 24-in. diameter corrugated steel pipe (Photo 4), which runs through the embankment near the left abutment. The pipe has no control features or trash rack. Evidence of past flow through the pipe was noted. There is no intake structure and the potential exists for erosion of the embankment around the inlet during high flows. The pipe is partially blocked by vegetation at its upstream end.

The auxiliary spillway is an uncontrolled open channel in the left abutment (Photo 5). It is unlined, its cross-section is irregular in shape and it is equipped with a fish control fence. The crest of the auxiliary spillway is approximately 1 ft higher than the invert elevation of the main spillway pipe. The soil in which the spillway is cut is judged to be highly erodible; a deep gully has been eroded by water flowing from the abutment into the reservoir upstream of the spillway (Photo 5 and Photo 6).

d. Reservoir area. The area surrounding the reservoir is densely wooded and little sediment appears to be transported from the surrounding hillsides into the reservoir. The natural slopes are approximately 3(H) to 1(V). There are some near-vertical cut slopes on the right bank where borrow was taken from the reservoir area (Photo 6). These slopes could slump into the reservoir when the water level rises. Because of the low water level at the time of

inspection, the reservoir bottom was visible. It appeared to be about 5 ft above the natural valley floor. This may be partially due to sedimentation and partially due to the clay liner reported to have been added by the owner to decrease leakage.

- e. Downstream channel. Neither the main, nor auxiliary spillway downstream channels are well-defined. Both are unlined channels in highly erodible material (Photo 7). Even during periods of low flow, the outflow from the main spillway is likely to flow along the downstream toe of the dam. The sides of the downstream channel of the auxiliary spillway are low and likely to be eroded or overtopped during high flows. The discharge would then flow along the downstream toe of the dam, where erosion could result in failure of the dam. The natural downstream channel below the dam is heavily wooded.

3.2 Evaluation

The visual inspection indicates that the dam embankment is in generally good condition. No evidence of disruption of the vertical or horizontal alignment of the dam crest was noted. However, the gravelly silt used in the dam construction appears to have a moderate to high susceptibility to erosion. Little erosion protection is offered by the vegetation on the embankment.

The auxiliary spillway and both spillway discharge channels are unlined. There is considerable potential for erosion in these areas and along the downstream toe of the dam resulting from spillway discharge.

SECTION 4 OPERATIONAL PROCEDURES

4.1 Procedures

The inspection did not identify any operational procedures at this dam. There were no facilities identified which required operation. The reservoir pool elevation is controlled by the crest elevations of the spillways.

4.2 Maintenance of the Dam

No records of maintenance on this dam were available (see Post construction changes, Section 6.1d). The embankment appears to be in good condition. However, the spillways and discharge channels require additional construction work for safe operation. Some small trees are just becoming established on the embankment. These should be removed before they become large enough to pose a potential hazard to the dam.

4.3 Maintenance of Operating Facilities

No facilities requiring operation were identified at this dam.

4.4 Description of Any Warning System in Effect

The visual inspection did not identify any warning system at this dam.

4.5 Evaluation

There are no operational procedures or records of maintenance at this dam. This is considered a deficiency. The appurtenant facilities appear to be in generally poor condition. A program of scheduled inspections and maintenance is recommended.

The feasibility of a practical warning system should be evaluated to alert the downstream residents in the event potentially hazardous conditions develop at the dam during periods of heavy precipitation.

SECTION 5 HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. Design data. No hydrologic or hydraulic design data were available for evaluation of this dam or reservoir; however, the dimensions of the dam were surveyed. The survey data were supplied by James McCaul, III and Associates of Potosi, Missouri. Other relevant data were measured during the visual inspection or estimated from topographic mapping. The map used in the analysis was the USGS Glover, Missouri 7.5-minute quadrangle map (1968).
- b. Experience data. No recorded rainfall, runoff, discharge, or pool stage historical data were found for this reservoir. No record or evidence was noted of past overtopping of the embankment.
- c. Visual inspection.
 1. Watershed. The watershed is undeveloped and covered with natural woodland. The reservoir area is about 5 percent of the total watershed area of 0.09 square miles.
 2. Reservoir. The reservoir and dam are best described by the maps and photographs enclosed herewith.
 3. Spillways. The spillways are located at the south end of the dam (left abutment). The main spillway consists of an uncontrolled, 24-in. diameter corrugated pipe with an entrance elevation of 795.9 ft. The auxiliary spillway is an uncontrolled earth spillway with crest at elevation 796.9 ft.
 4. Seepage. There was no visible seepage through the dam. However, the reservoir was practically empty at the time of the visual inspection.
- d. Overtopping potential. One of the primary considerations in the evaluation of the Lawless Lake Dam is the assessment of the potential for overtopping and consequent failure by erosion of the dam. The lowest portion of the dam crest,

elevation 798.9 ft, was considered to be the top of the dam for the purpose of determining overtopping potential.

Hydrologic analyses of this dam for the 1 and 10 percent probability-of-occurrence and Probable Maximum Flood (PMF) events were all based on initial water surface elevations equal to the invert elevation of the 24-inch diameter main spillway pipe. The results of the analyses indicate that a flood greater than 14 percent of the PMF will overtop the dam. The total discharge capacity for both spillways at 14 percent of the PMF is approximately 100 ft³/sec. The PMF is defined as the flood event that may be expected to occur from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The analyses also indicates that the spillway will pass the 1 percent probability-of-occurrence (100-year) flood event without overtopping the dam. The 1 percent probability-of-occurrence flood event is the flood event that has a 1 percent chance of being equalled or exceeded in any year, or would be expected to be equalled or exceeded on the average once in every 100 years.

The following overtopping data for various flood events were computed for the dam assuming no erosion of the spillways or embankment.

Precipitation Event	Maximum Reservoir Elevation, ft, (MSL)	Maximum Depth Over Dam, ft	Maximum Outflow, ft ³ /sec	Duration of Overtopping, hrs
1% Prob	798.7	0	60	0
14% PMF	798.9	0	100	0
50% PMF	799.6	0.7	460	2.9
100% PMF	800.0	1.1	940	5.8

It is recommended that a spillway design flood of at least 50 percent of the PMF be used for this small dam. A spillway system capable of passing at least 50 percent of the PMF should be designed, provided that the spillway design recommendations incorporate some of the measures discussed below. This recommendation is based on the broad downstream valley (Photo 1).

It should be noted, however, that with the present spillway configuration, the depth of overtopping at 100 percent of the PMF will reach 1.1 ft and the dam will be overtopped for almost 6 hours. During this period, significant erosion would very likely take place and could lead to a breach of the dam.

It is suggested, therefore, that when the recommended spillway design study is made, particular attention be directed toward the evaluation of the remaining erosion hazard in the event of a 100 percent PMF storm. Whatever design approach is chosen, one of the study objectives should be to minimize the likelihood of dam embankment erosion for storm events exceeding 50 percent of the PMF.

The input data and output summaries for the hydrologic analyses are presented in Appendix B.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual inspection. The visual inspection of Lawless Lake Dam revealed no evidence of disruption of the vertical or horizontal alignment of the dam crest. There was no evidence of detrimental settlement, sinkhole development, or cracking of the dam embankment. Some minor gully erosion has occurred on the unvegetated upper part of the downstream slope. It is recommended that grass cover be provided for this area.
- b. Design and construction data. All information on the design and construction of the dam was obtained through phone interviews with the owner, Mr David J. Lawless, and is presented in Sections 1.2g and 2.2.

Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available. This is considered a deficiency.

- c. Operating records. No operating records or water level records are maintained for this facility.
- d. Post construction changes. After the first filling of the reservoir a leak was identified, using dye tracers, which was thought by the owner to be occurring along a solution feature in the bedrock. The reservoir was emptied and an 18 ft deep cutoff trench was reported to have been dug along the downstream toe and backfilled with compacted clay. In addition, the lake bed was lined with clay.

Since the reservoir has been empty for some time, the clay liner is likely to be dessicated and may not be effective. However, if the downstream cutoff is effective, high pore pressures could develop under the downstream slope. This could result in failure of the dam.

- e. Seismic stability. The dam is located in Seismic Zone 2, to which the guidelines assign a moderate damage potential. In view of the silty soil used in the dam construction, liquefaction is possible during a moderate seismic event. However, since soil property data or static stability analyses are not available for review, the seismic stability cannot be evaluated.

SECTION 7 ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

- a. **Safety.** On the basis of the visual inspection, the Lawless Lake Dam embankment is judged to be in generally good condition. However, the hydraulic and hydrologic analyses indicate the spillways will pass only about 14 percent of the PMF, which is considered a deficiency under the guidelines. The embankment material is considered to have a low to moderate resistance to erosion; in the event of overtopping with high flow velocities, sufficient erosion could occur to result in failure of the dam.

Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is also considered a deficiency.

- b. **Adequacy of information.** The visual inspection and interviews with the dam owner provided the base of information for the conclusions and recommendations in this Phase I report.

The lack of seepage and stability analyses as recommended in the guidelines precludes an evaluation of the structural and seismic stability of the dam. The lack of these analyses is considered a deficiency which should be rectified.

- c. **Urgency.** The deficiencies described in this report could affect the risk of failure of this dam. It is suggested that the recommendations in Section 7.2b on the spillway capacity re-design be implemented without undue delay to prevent the development of hazardous conditions at the dam. Other recommendations presented in Section 7.2b and 7.2c should be implemented as soon as practical.

- d. **Necessity for Phase II.** In accordance with the "Recommended Guidelines for Safety Inspection of Dams," the subject investigation is a minimum study. This study revealed that additional in-depth investigations are needed to complete the assessment of the safety of the dam. These investigations which should be performed without undue delay are described in Section 7.2b. It is our understanding from discussions with the St Louis District that any additional investigations are the responsibility of the owner.

7.2 **Remedial Measures**

- a. **Alternatives.** There are several general options which may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these general options are:
1. Remove the dam, or breach it to prevent the storage of water;
 2. Increase the height of the dam and/or spillway size to pass the recommended spillway design flood without overtopping the dam;
 3. Purchase downstream land that would be adversely impacted by dam failure and restrict human occupancy;
 4. Provide a highly reliable flood warning system (generally does not prevent damage, but diminishes the chances for loss of life).
- b. **Recommendations.** The following specific remedial measures and additional studies are recommended for this dam, to be undertaken without undue delay.
1. Prepare a more detailed hydraulic/hydrologic analysis and design a spillway system capable of passing at least 50 percent of the Probable Maximum Flood, without overtopping the dam. The recommended spillway design flood is based on SLD guidelines and the broad downstream valley. This design study should include an evaluation of the risk of embankment erosion for storms greater than 50 percent of the PMF. The spillway system should be protected to prevent erosion.

2. Deepen the channel or raise the sides of the main and auxiliary spillway discharge channels to direct flow away from the toe of the dam. The need for lining the channels should be considered.

3. Provide a trash rack for the 24-in. diameter main spillway pipe and provide erosion protection to the embankment at the inlet to the pipe.

The following measures should be undertaken as soon as practical.

4. Prepare seepage and stability analyses for the dam in accordance with the "Recommended Guidelines for Safety Inspection of Dams."

5. Remove small trees from the embankment before they become large enough to pose a potential hazard to the dam.

6. Provide adequate grass cover for the upper part of the downstream face.

7. Evaluate available options for an effective and practical warning system to alert downstream residents should potentially hazardous conditions develop at the dam.

It is recommended that these remedial measures and studies be done by, or under the guidance of an engineer experienced in the design and construction of earth dams.

- c. O and M procedures. A program of periodic inspections and maintenance should be implemented for the dam as soon as practical. These recommended periodic inspections will become more meaningful as the reservoir level rises in the future and is maintained at its design level. This program should include but not be limited to the following items.

1. Monitor pore pressures along the downstream toe generated as a result of the location of the cutoff trench.

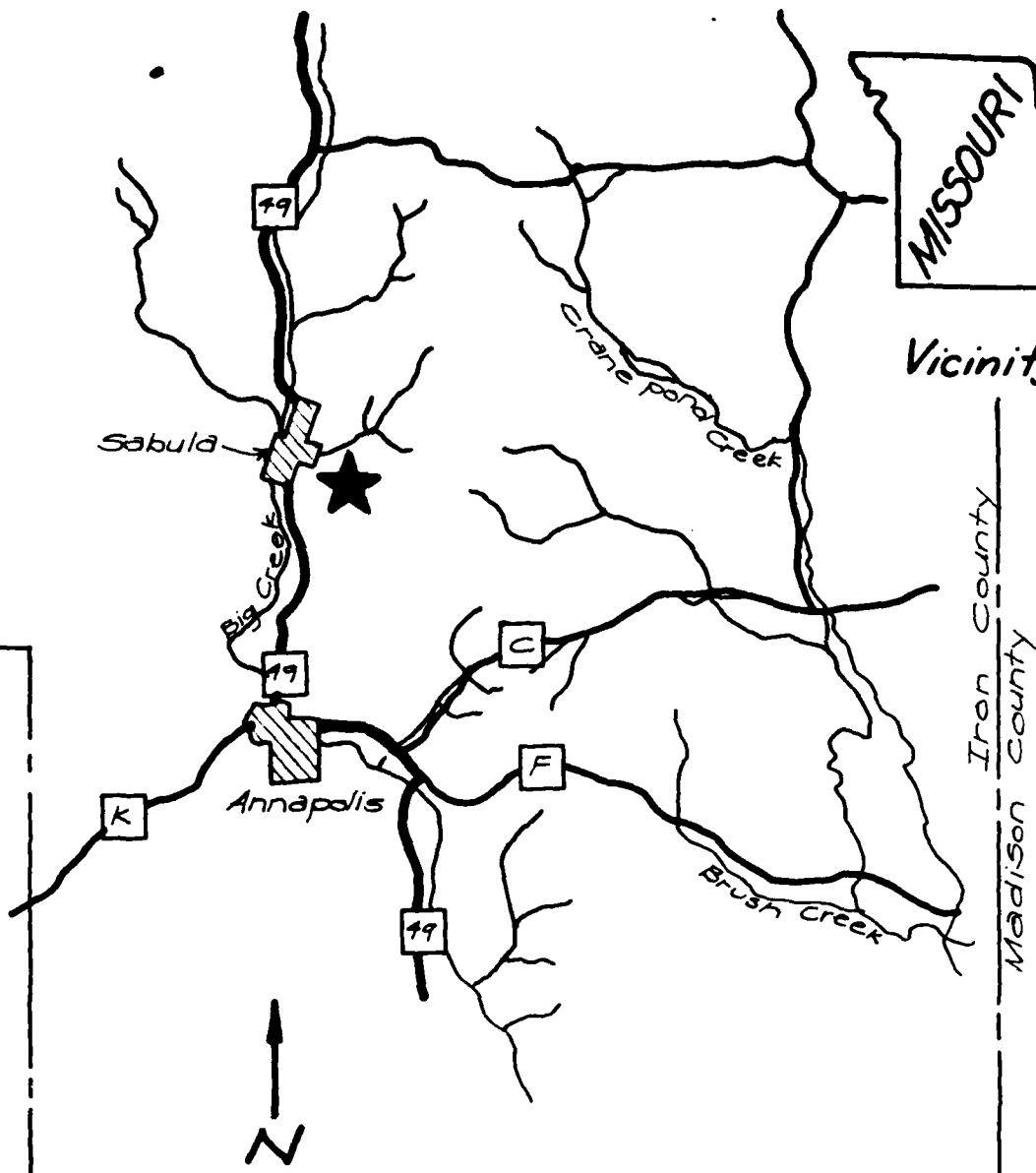
2. Inspect the embankment to identify any signs of slope instability such as slumping and cracking.
3. Inspect the abutments and embankment for signs of seepage or erosion. Should the reservoir become full, particular attention should be directed to the spring which was observed downstream of the dam after its first filling.
4. Inspect the spillway area and the discharge channel to identify any significant erosion following heavy precipitation.
5. Prepare records of recommended and performed maintenance on the facilities.

This program should be under the guidance of an engineer experienced in the design, construction and maintenance of earth dams.

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- US Department of Commerce, US Weather Bureau, 1956, Seasonal Variation of the Probable Maximum Precipitation East of the 105th Meridian for Areas from 10 to 1,000 Square Miles and Durations of 6, 12, 24 and 48 Hours, Hydrometeorological Report No. 33.

Reynolds County
Iron County



Vicinity Map

Iron County
Madison County

0 2 4
Scale, miles

Legend

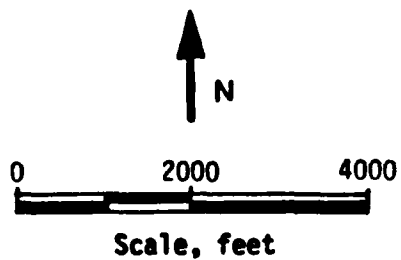
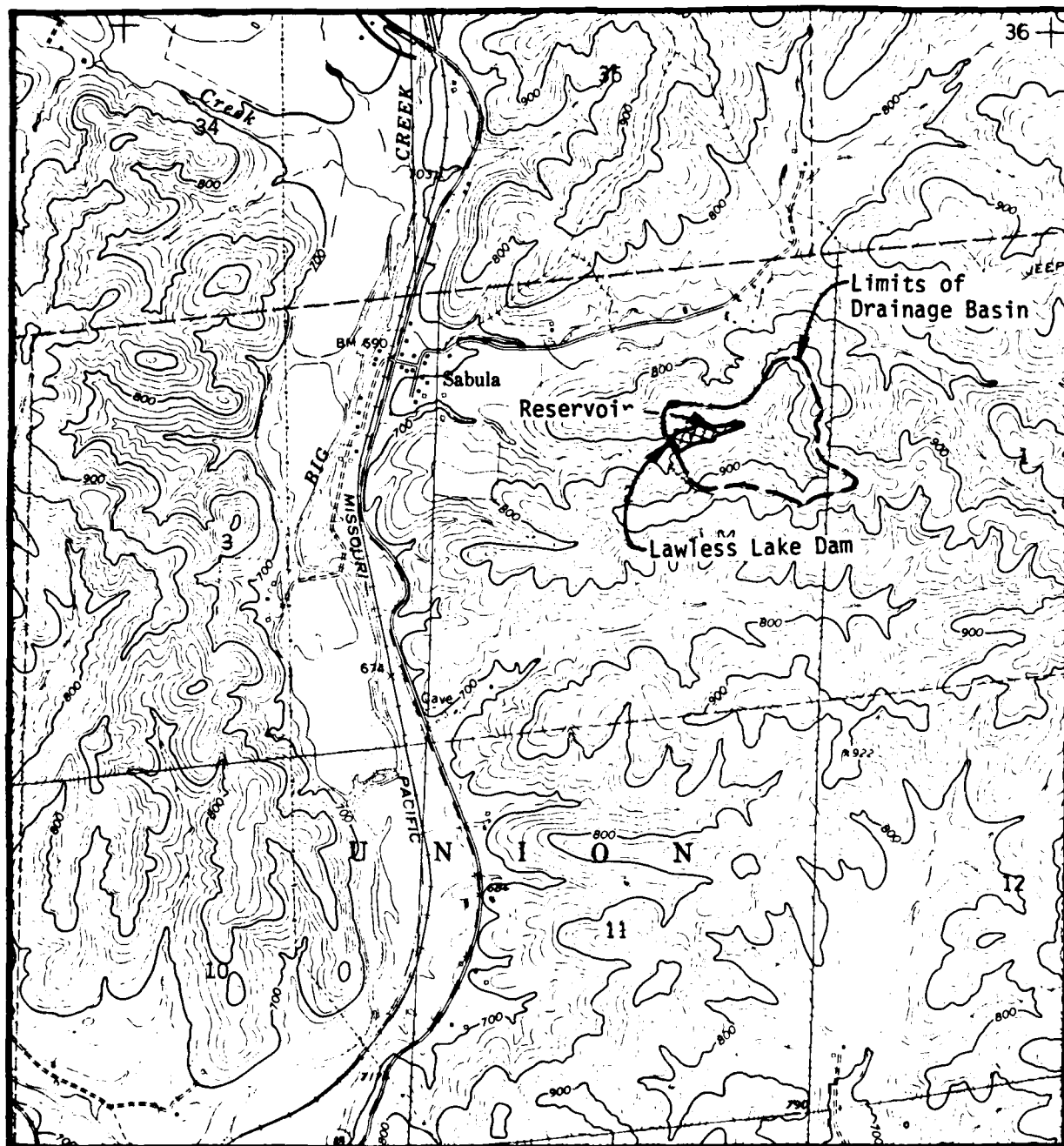
- County Line
- State highway and Route No.
- ~~~~~ River or Creek
- ▨ City or Town
- ★ Project location

SITE LOCATION MAP

LAWLESS LAKE DAM

MO 31717

Fig. 1



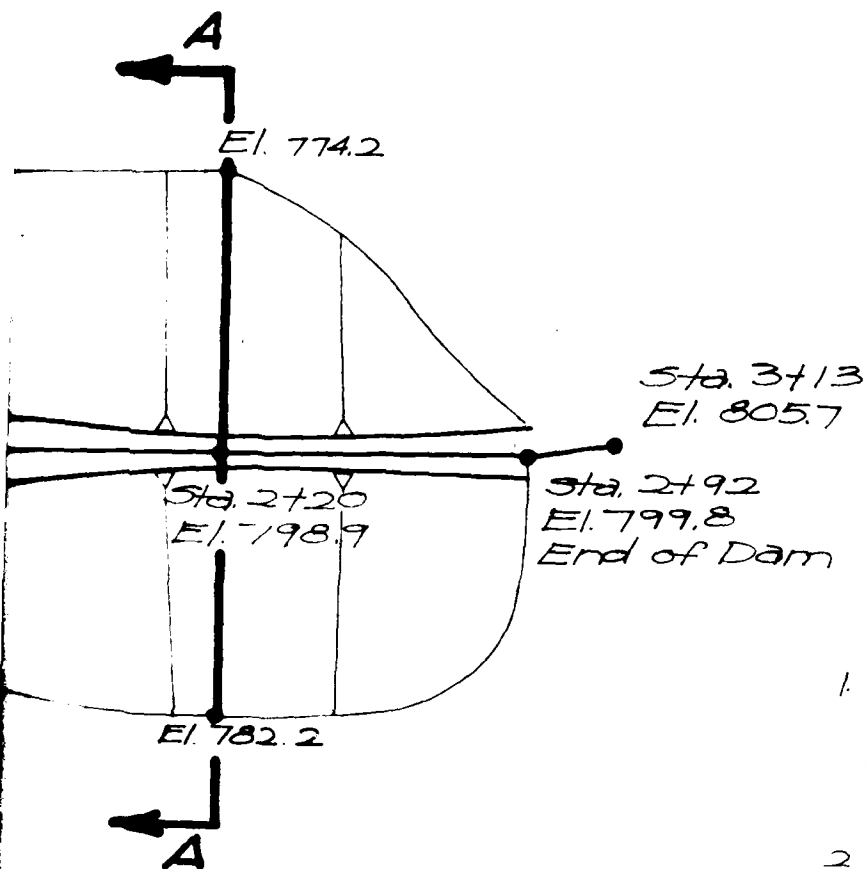
Topography from USGS
Glover (1968) 7.5 min.
quadrangle map.

DRAINAGE BASIN AND SITE TOPOGRAPHY

LAWLESS LAKE DAM

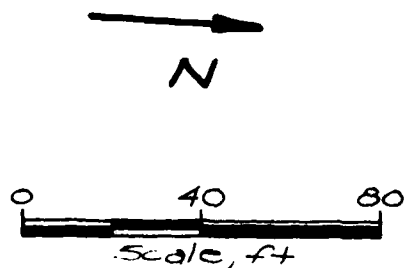
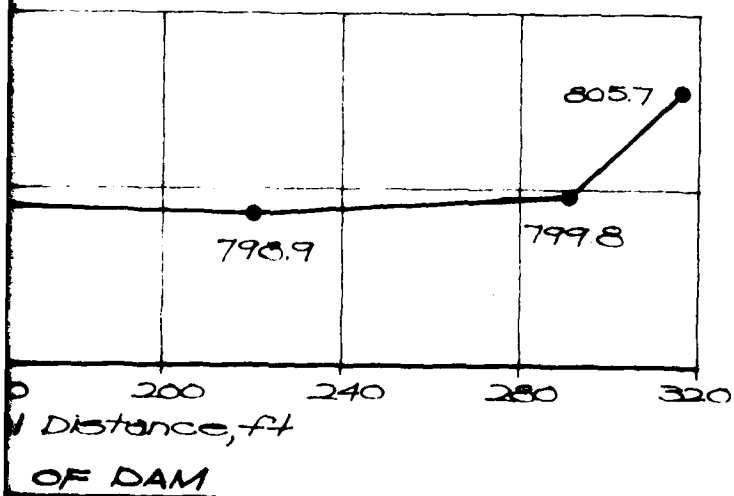
MO. 31717

Fig. 2

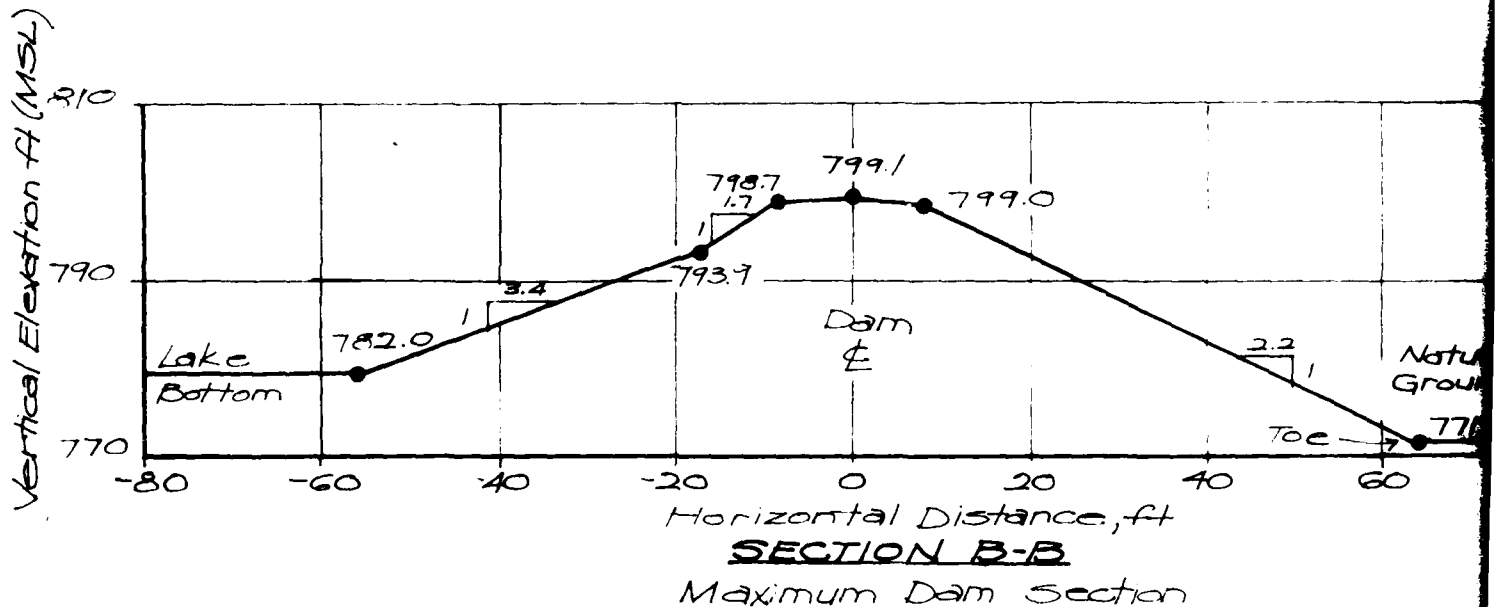
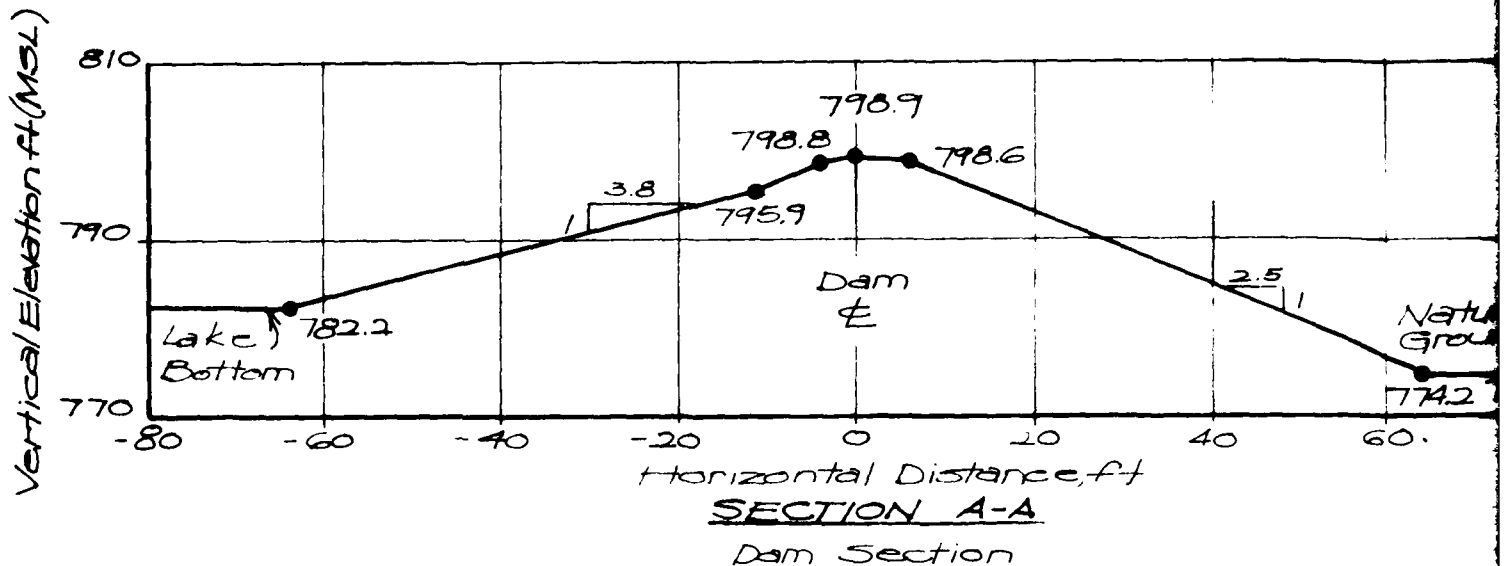


- Notes:
1. Survey data supplied by James F. McCaul, III and Associates, Consulting Engineers, Land Surveyors, Potosi, MO. 63664
 2. High Water line at El. 796.9 ft. Water level at time of inspection at El. 779.1 ft (MSL)

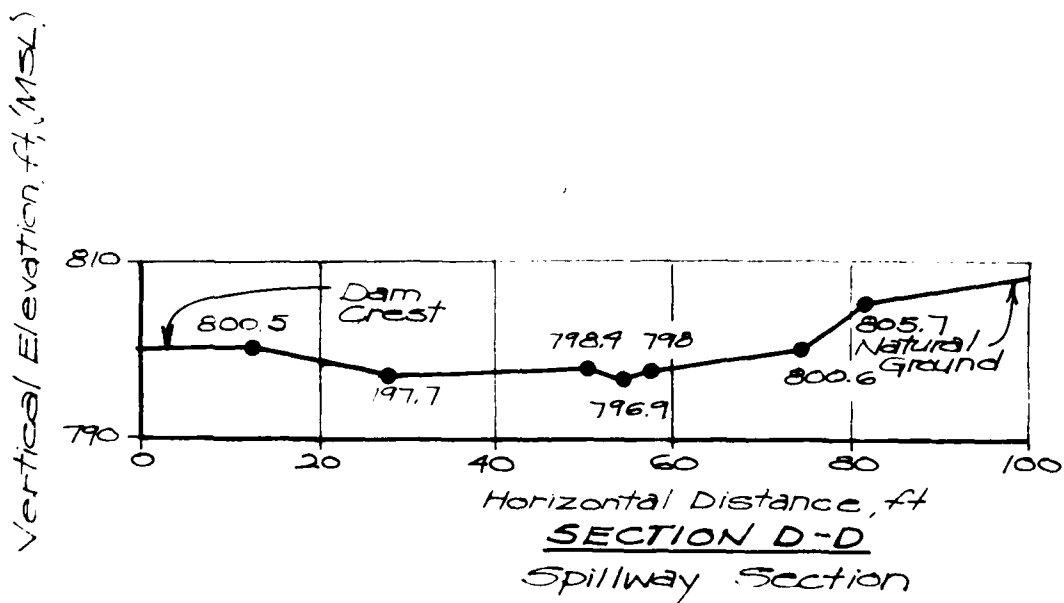
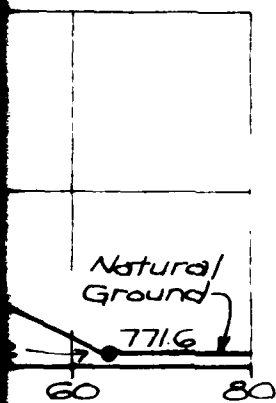
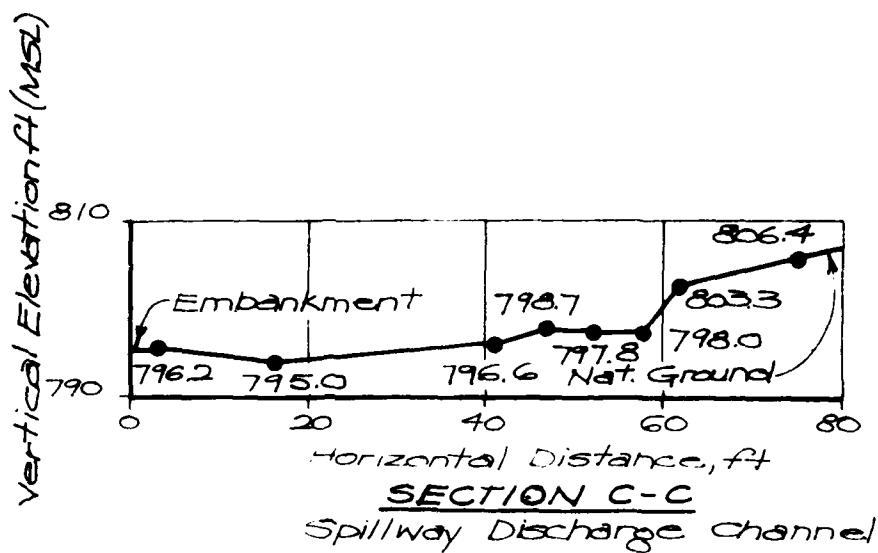
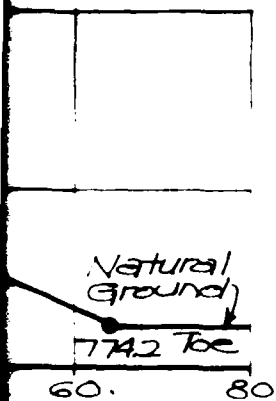
DAM



PLAN AND PROFILE OF DAM	
LAWLESS LAKE DAM	
MO 81717	Fig. 3A



Note:
Survey data supplied
by James F. McCaul, III
and Associates; Consult-
ing Engineers/Land Sur-
veyors. Potosi, Mo. 63664



DAM AND SPILLWAY CROSS-SECTIONS

LAWLESS LAKE DAM

MD 81717

Fig. 3-B

Dam Location



Scale, mile



Legend

Or	Roubidoux Formation
	Gasconade Dolomite Gunter Sandstone Member
Cep	Eminence Dolomite
	Potosi Dolomite
	Derby-Doerun Dolomite
Ceb	Davis Formation
	Bonneterre Formation Whetstone Creek Member Sullivan Siltstone Member
	Reagan Sandstone (subsurface, western Missouri)
	Lamotte Sandstone
	Diabase (dikes and sills)
	St. Francois Mountains Intrusive Suite
	St. Francois Mountains Volcanic Supergroup

REGIONAL GEOLOGIC MAP

LAWLESS LAKE DAM

MO 31717

Fig. 4

APPENDIX A
Photographs

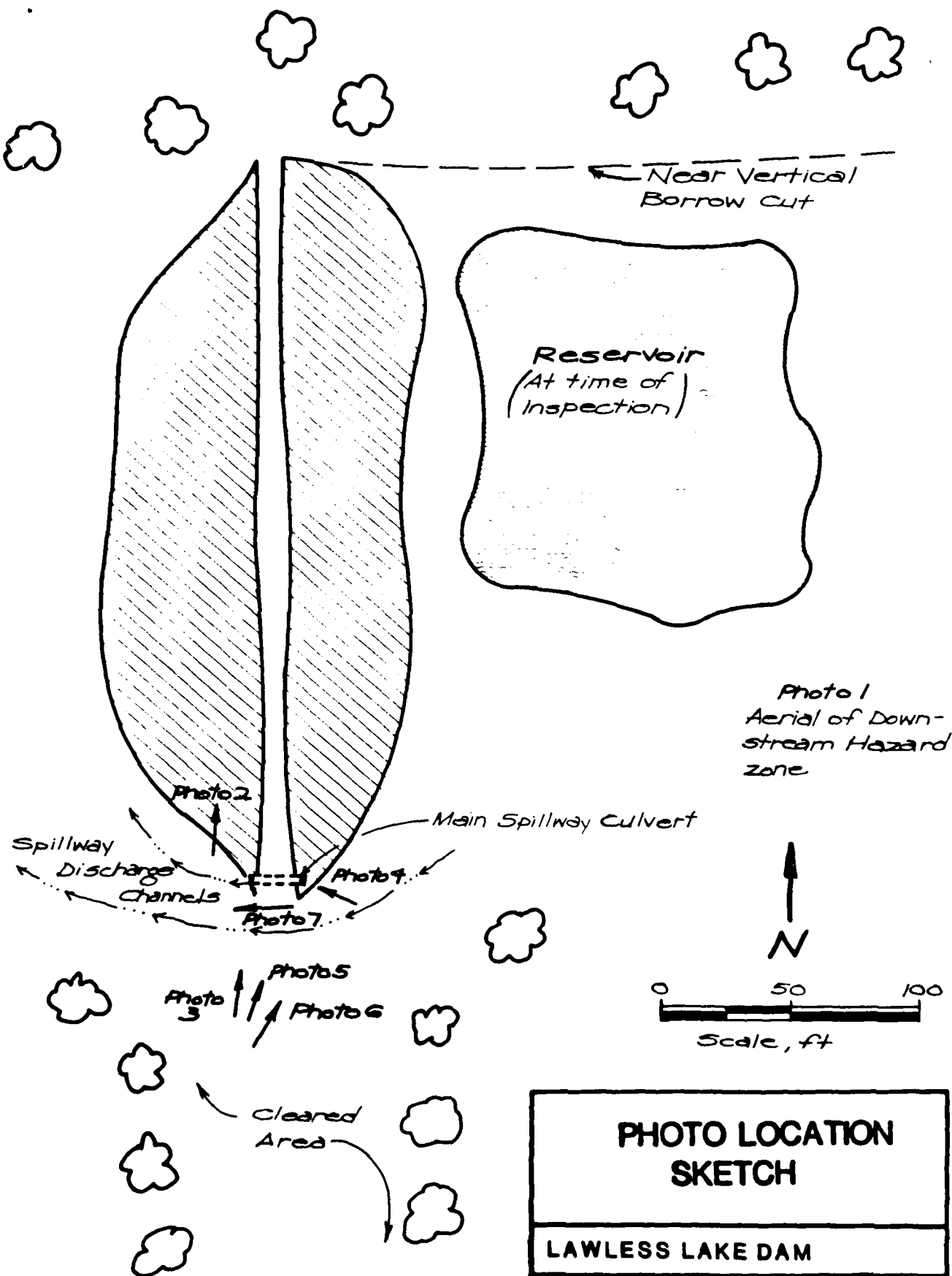
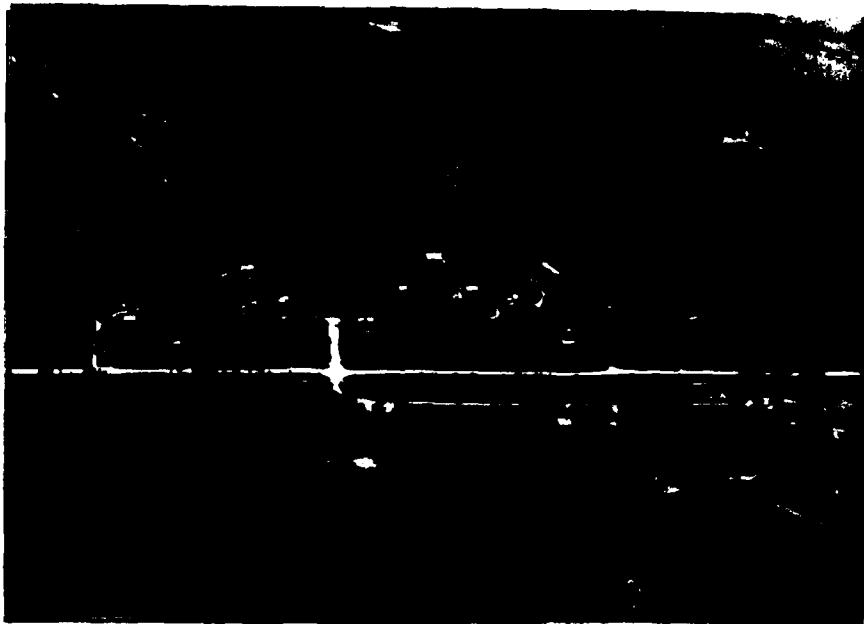


PHOTO LOCATION SKETCH

LAWLESS LAKE DAM

MO 31717

Fig. A-1



1. Downstream hazard zone, looking east. Reservoir is visible near center of top edge of photo.



2. Downstream slope, looking north. Note sparsely vegetated upper slope.



3. Dam crest, looking north.



4. Inlet to 24-in. diameter main spillway pipe.
Note partial blockage by vegetation.



5. Auxiliary spillway, looking northeast. Note fish control fence and erosion gully leading into reservoir.



6. Reservoir area, looking northeast. Note low water level and near-vertical cut slopes. Also note erosion gully from left abutment into reservoir (bottom of photo).



7. Spillway discharge channels, looking west (downstream). The main spillway discharges to the right of the low ridge in the foreground, the auxiliary spillway to the left.

APPENDIX B
Hydraulic/Hydrologic Data and Analyses

APPENDIX B

Hydraulic/Hydrologic Data and Analyses

B.1 Procedures

- a. General. The hydraulic/hydrologic analyses were performed using the "HEC-1, Dam Safety Version (1 Apr 80)" computer program. The inflow hydrographs were developed for various precipitation events by applying them to a synthetic unit hydrograph. The inflow hydrographs were subsequently routed through the reservoir and appurtenant structures by the modified Puls reservoir routing option.
- b. Precipitation events. The Probable Maximum Precipitation (PMP) and the 1 and 10 percent probability-of-occurrence events were used in the analyses. The total rainfall and corresponding distributions for the 1 and 10 percent probability events were provided by the St. Louis District, Corps of Engineers. The Probable Maximum Precipitation was determined from regional curves prepared by the US Weather Bureau (Hydrometeorological Report Number 33, 1956). The Probable Maximum Precipitation distribution was computed by the HEC-1 program internally using standard EM-1110-1411 method.
- c. Unit hydrograph. The Soil Conservation Services (SCS) Dimensionless Unit Hydrograph method (SCS, 1971, Hydrology: National Engineering Handbook, Section 4) was used in the analysis. This method was selected because of its simplicity, applicability to drainage areas less than 10 mi², and its easy availability within the HEC-1 computer program.

The watershed lag time was computed using the SCS "curve number method" by an empirical relationship as follows:

$$L = \frac{l^{0.8} (s+1)^{0.7}}{1900 Y^{0.5}} \quad (\text{Equation 15-4})$$

where: L = lag in hours
 l = hydraulic length of the watershed in feet = 2700
 $s = \frac{1000}{CN} - 10 = 5.4$
 CN = AMC II hydrologic soil curve number as indicated in Section B.2e.
 Y = average watershed land slope in percent = 19.

This empirical relationship accounts for the soil cover, average watershed slope and hydraulic length.

With the lag time thus computed, another empirical relationship is used to compute the time of concentration as follows:

$$T_c = \frac{L}{0.6} \quad (\text{Equation 15-3})$$

where: T_c = time of concentration in hours
 L = lag in hours.

Subsequent to the computation of the time of concentration, the unit hydrograph duration was approximated utilizing the following relationship:

$$\Delta D = 0.133T_c \quad (\text{Equation 16-12})$$

where: ΔD = duration of unit excess rainfall
 T_c = time of concentration in hours.

The final duration was selected to provide at least three discharge ordinates prior to the peak discharge ordinate of the unit hydrograph. For this dam, the unit hydrograph duration of 5 minutes was used.

- d. Infiltration losses. The infiltration losses were computed by the HEC-1 computer program internally using the SCS loss function. The curve numbers of SCS loss rate procedure were established taking into consideration the variables of: (a) antecedent moisture condition, (b) hydrologic soil group classification, (c) vegetative cover and (d) present land usage in the watershed. In addition, the computed basin loss was reduced proportional to the impervious area in the drainage basin.

Antecedent moisture condition III (AMC III) was used for the PMF events and AMC II was used for the 1 and 10 percent probability events, in accordance with the guidelines. The remaining variables are defined in the SCS procedure and judgements in their selection were made on the basis of visual field inspection.

- e. Starting elevations. Reservoir starting water surface elevations for this dam were set as follows:

- (1) 1 and 10 percent probability events - outlet pipe invert elevation 795.9 ft
- (2) Probable Maximum Storm - outlet pipe invert elevation 795.9 ft

- f. Spillway Rating Curve. Flow through the 24-inch diameter main spillway pipe was computed using the US Bureau of Public Roads culvert capacity nomograph. The HEC-2 computer program was used to compute the auxiliary spillway rating curve using the auxiliary spillway discharge channel cross section and conveyance characteristics. A Manning's "n" value of .025 was used in the analysis of the auxiliary spillway.

B.2 Pertinent Data

- a. Drainage area. 0.09 mi²

- b. Storm duration. A unit hydrograph was developed by the SCS method option of HEC-1 program. The design storm of 24 hours duration was divided into equal intervals equal to the unit hydrograph duration of 5 minutes in order to develop the inflow hydrograph.
- c. Lag time. 0.25 hr
- d. Hydrologic soil group. B & C
- e. SCS curve numbers.
 - 1. For PMF- AMC III - Curve Number 82
 - 2. For 1 and 10 percent probability-of-occurrence events - AMC II - Curve Number 65
- f. Storage. Elevation-area data were developed by planimetering areas at various elevation contours on the USGS Glover, Missouri (1968) 7.5-minute quadrangle map. The data were entered on the \$A and \$E cards so that the HEC-1 program could compute storage volumes.
- g. Outflow over dam crest. As the profile of the dam crest is irregular, flow over the crest was computed according to the "Flow Over Non-Level Dam Crest" supplement to the HEC-1 User's Manual. The crest length-elevation data and hydraulic constants were entered on the \$D, \$L, and \$V cards.
- h. Outflow capacity. The combined outflow rating curve was computed by combining the flow through the 24-in. diameter main spillway pipe and flow over the auxiliary spillway. The capacity of the main spillway culvert was computed using the US Bureau of Public Roads culvert capacity nomograph.

The auxiliary spillway rating curve was developed from the cross section data of the spillway and the downstream channel, using the HEC-2 backwater program. The rating curve data for the main spillway pipe and auxiliary spillway were combined and entered on the Y4 and Y5 cards of the HEC-1 program.
- i. Reservoir elevations. For the 50 and 100 percent of the PMF events, the starting reservoir elevation was 795.9 ft, the main spillway pipe invert elevation. For the 1 and 10 percent probability-of-occurrence events, the starting reservoir elevation was also 795.9 ft, the main spillway pipe invert elevation.

B.3 Results

The results of the analyses as well as the input values to the HEC-1 program follow in this Appendix. Only the results summaries are included, not the intermediate output. Complete copies of the HEC-1 output are available in the project files.

 64000 HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION... JULY 1978
 LAST MODIFICATION 01 APR 80

1 A1 LAWLESS LAKE DAM 031717, IRON COUNTY, MISSOURI
 2 A2 WOODWARD-CLYDE CONSULTANTS, HOUSTON JOB 80C2247600
 3 A3 PROBABLE MAXIMUM FLOOD (PMF) ANALYSIS

4	0	299	3	5	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0

8 K1 INFL04
 9 K1 LAWLESS LAKE DAM INFLOW COMPUTATIONS, PROBABLE MAXIMUM FLOOD
 10 M 1

11	0	0	26	102	120	130	-1	-02
12	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0

15 K1 3-25
 16 K1 1
 17 K1 1
 18 K1 1
 19 K1 1
 20 K1 1
 21 K1 1
 22 K1 1
 23 K1 1
 24 K1 1
 25 K1 1
 26 K1 1
 27 K1 1

..... FLOOD ROUTING AND OVERTOPPING ANALYSIS

19	V4	795.9	796.9	798.0	798.6	798.9	799.3	799.6	800.4	801.1
20	V5	0	0	0	0	0	0	0	0	0
21	V6	0	1.86	2.28	2.53	2.65	2.79	3.60	5.12	8.05
22	V7	0	780	790	795.9	798.9	800	810	820	830
23	V8	795.9	796.9	798.0	798.6	798.9	799.3	799.6	800.4	801.1
24	V9	0	0	0	0	0	0	0	0	0
25	V10	0	0	0	0	0	0	0	0	0
26	V11	0	0	0	0	0	0	0	0	0
27	V12	0	0	0	0	0	0	0	0	0

Input Data
 Various PMF Events
 Lawless Lake Dam
 MO 31717
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FLOOD HYDR APM PACKAGE (INEC-1)
DAB SAFETY VERSIJA JULY 1978
LAST MODIFICATION 01 APR 80

RUN DATE= 01/06/83
TIME= 14.01.16

LAWLESS LAKE DAM 031717, IRON COUNTY, MISSOURI
WOBWARD-CLYDE CONSULTANTS, HOUSTON JOB 00C224Y100
PROBABLE MAXIMUM FLOOD (PMF) ANALYSIS

JOB SPECIFICATION

NO	MHR	MMIN	IDAY	IMR	IMIN	METC	IPLT	IPRT	INSTAN
299	0	5	0	0	0	0	0	0	0
	JOPER			NMT	LROPT	TRACE			
	5			0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
MPLAN= 1 MRYIO= 2 LRYIO= 1

RTIOS= .50 1.00

SUB-AREA RUNOFF COMPUTATION

LAWLESS LAKE DAM INFLOW COMPUTATIONS, PROBABLE MAXIMUM FLOOD

ISTAD	ICOMP	IECON	ITAPE	JPLY	JPRY	ISAME	ISTAGE	IAUTO
INFLOW	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IMVDC	IUMG	TAREA	SMAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.09	0.00	.09	1.00	0.000	0	0	0

PRECIP DATA

SPEC	PMS	R6	R12	R24	R48	R72	R96
0.00	26.00	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

-ROPT	STRKR	DLTKR	RTIOL	ERAIN	STAKS	RTIOK	STRYL	CMSTL	ALSMX	RYTMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-82.00	0.00	0.00

CURVE NO = -82.00 METRESS = -1.00 EFFECT CM = 82.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .25

RECESSION DATA

STRIO= -1.00 ORCSN= -.05 RTIOR= 5.00

UNIT HYDROGRAPH 17 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .25 VOL= 1.00
26. 90. 144. 112. 67. 42. 27. 17. 11.
7. 3. 2. 1. 1. 0. 0.

END-OF-PERIOD FLOW

MO.DA	HR.MM	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MM	PERIOD	RAIN	EXCS	LOSS	COMP Q
1-01	.00	1	.01	0.03	.01	0.	1-01	12.30	150	.22	.21	.01	126.

Output Summary
Various PMF Events
Lawless Lake Dam
MO 31717
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SNIT HYDROGRAPH 17 END OF PERIOD ORIGINATES. TC= 0.00 HOURS. LAG= .25 VOL= 1.00
 26. 90. 144. 112. 67. 42. 17. 11.
 7. 4. 1. 0.

E40-OF-PERIOD FLOW							Output Summary Various PMF Events Lawless Lake Dam MO 31717 B6						
MO-DA	HR-MM	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO-DA	HR-MM	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	0.05	1	.01	0.03	.01	0.	1.01	12.30	150	.22	.21	.01	126.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.35	151	.22	.21	.01	133.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.40	152	.22	.21	.01	137.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.45	153	.22	.21	.01	140.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.50	154	.22	.21	.01	142.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.55	155	.22	.21	.01	143.
1.01	.35	7	.01	0.00	.01	0.	1.01	13.00	156	.22	.21	.01	144.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.05	157	.27	.25	.01	146.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.10	158	.27	.25	.01	151.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.15	159	.27	.25	.01	157.
1.01	.55	11	.01	0.00	.01	0.	1.01	13.20	160	.27	.25	.01	164.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.25	161	.27	.26	.01	169.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.30	162	.27	.26	.01	172.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.35	163	.27	.26	.01	174.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.40	164	.27	.26	.01	176.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.45	165	.27	.26	.01	177.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.50	166	.27	.26	.01	177.
1.01	1.30	18	.01	0.00	.01	0.	1.01	13.55	167	.27	.26	.01	179.
1.01	1.35	19	.01	0.00	.01	0.	1.01	14.00	168	.27	.26	.01	178.
1.01	1.40	20	.01	0.00	.01	0.	1.01	14.05	169	.33	.32	.01	181.
1.01	1.45	21	.01	0.00	.01	0.	1.01	14.10	170	.33	.32	.01	187.
1.01	1.50	22	.01	0.00	.01	0.	1.01	14.15	171	.33	.32	.01	196.
1.01	1.55	23	.01	0.00	.01	0.	1.01	14.20	172	.33	.32	.01	206.
1.01	2.00	24	.01	0.03	.01	0.	1.01	14.25	173	.33	.32	.01	213.
1.01	2.05	25	.01	0.00	.01	0.	1.01	14.30	174	.33	.32	.01	218.
1.01	2.10	26	.01	0.00	.01	0.	1.01	14.35	175	.33	.32	.01	221.
1.01	2.15	27	.01	0.00	.01	0.	1.01	14.40	176	.33	.33	.01	223.
1.01	2.20	28	.01	0.00	.01	0.	1.01	14.45	177	.33	.33	.01	224.
1.01	2.25	29	.01	0.00	.01	0.	1.01	14.50	178	.33	.33	.01	225.
1.01	2.30	30	.01	0.00	.01	0.	1.01	14.55	179	.33	.33	.01	226.
1.01	2.35	31	.01	0.00	.01	0.	1.01	15.00	180	.33	.33	.01	226.
1.01	2.40	32	.01	0.00	.01	0.	1.01	15.05	181	.20	.20	.00	223.
1.01	2.45	33	.01	0.00	.01	0.	1.01	15.10	182	.40	.40	.01	217.
1.01	2.50	34	.01	0.00	.01	0.	1.01	15.15	183	.40	.40	.01	217.
1.01	2.55	35	.01	0.00	.01	0.	1.01	15.20	184	.60	.60	.01	232.
1.01	3.00	36	.01	0.00	.01	0.	1.01	15.25	185	.71	.70	.01	263.
1.01	3.05	37	.01	0.00	.01	0.	1.01	15.30	186	1.71	1.69	.02	345.
1.01	3.10	38	.01	0.00	.01	0.	1.01	15.35	187	2.92	2.80	.03	515.
1.01	3.15	39	.01	0.00	.01	1.	1.01	15.40	188	1.11	1.10	.01	522.
1.01	3.20	40	.01	0.00	.01	1.	1.01	15.45	189	.71	.70	.01	927.
1.01	3.25	41	.01	0.00	.01	1.	1.01	15.50	190	.60	.60	.00	926.
1.01	3.30	42	.01	0.03	.01	1.	1.01	15.55	191	.40	.40	.00	811.
1.01	3.35	43	.01	0.00	.01	1.	1.01	16.00	192	.40	.40	.00	694.
1.01	3.40	44	.01	0.00	.01	1.	1.01	16.05	193	.31	.31	.00	527.
1.01	3.45	45	.01	0.00	.01	1.	1.01	16.10	194	.31	.31	.00	490.
1.01	3.50	46	.01	0.00	.01	1.	1.01	16.15	195	.31	.31	.00	396.
1.01	3.55	47	.01	0.00	.01	1.	1.01	16.20	196	.31	.31	.00	308.
1.01	4.00	48	.01	0.00	.01	2.	1.01	16.25	197	.31	.31	.00	271.
1.01	4.05	49	.01	0.00	.01	2.	1.01	16.30	198	.31	.31	.00	290.
1.01	4.10	50	.01	0.00	.01	2.	1.01	16.35	199	.31	.31	.00	237.
1.01	4.15	51	.01	0.00	.01	2.	1.01	16.40	200	.31	.31	.00	229.
1.01	4.20	52	.01	0.00	.01	2.	1.01	16.45	201	.31	.31	.00	227.
1.01	4.25	53	.01	0.00	.01	2.	1.01	16.50	202	.31	.31	.00	220.
1.01	4.30	54	.01	0.00	.01	2.	1.01	16.55	203	.31	.31	.00	217.
1.01	4.35	55	.01	0.00	.01	2.	1.01	17.00	204	.31	.31	.00	216.
1.01	4.40	56	.01	0.03	.01	2.	1.01	17.05	205	.24	.24	.00	213.
1.01	4.45	57	.01	0.00	.01	2.	1.01	17.10	206	.24	.24	.00	207.
1.01	4.50	58	.01	0.00	.01	3.	1.01	17.15	207	.24	.24	.00	197.

Output Summary
Various PMF Events
Lawless Lake Dam
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1.01	4.20	52	.01	.00	.01	2.	1.01	16.45	201	.31	.31	.00	.00	220.
1.	4.25	53	.01	.00	.01	2.	1.01	16.50	202	.31	.31	.00	.00	220.
1.01	4.30	54	.01	.00	.01	2.	1.01	16.55	203	.31	.31	.00	.00	216.
1.01	4.35	55	.01	.00	.01	2.	1.01	17.00	204	.31	.31	.00	.00	216.
1.01	4.40	56	.01	.00	.01	2.	1.01	17.05	205	.24	.24	.00	.00	213.
1.01	4.45	57	.01	.00	.01	2.	1.01	17.10	206	.24	.24	.00	.00	207.
1.01	4.50	58	.01	.00	.01	3.	1.01	17.15	207	.24	.24	.00	.00	197.
1.01	4.55	59	.01	.00	.01	3.	1.01	17.20	208	.24	.24	.00	.00	198.
1.01	5.00	60	.01	.00	.01	3.	1.01	17.25	209	.24	.24	.00	.00	180.
1.01	5.05	61	.01	.00	.01	3.	1.01	17.30	210	.24	.24	.00	.00	176.
1.01	5.10	62	.01	.00	.01	3.	1.01	17.35	211	.24	.24	.00	.00	173.
1.01	5.15	63	.01	.00	.01	3.	1.01	17.40	212	.24	.24	.00	.00	171.
1.01	5.20	64	.01	.00	.01	3.	1.01	17.45	213	.24	.24	.00	.00	170.
1.01	5.25	65	.01	.00	.01	3.	1.01	17.50	214	.24	.24	.00	.00	170.
1.01	5.30	66	.01	.00	.01	3.	1.01	17.55	215	.24	.24	.00	.00	169.
1.01	5.35	67	.01	.01	.01	3.	1.01	18.00	216	.24	.24	.00	.00	169.
1.01	5.40	68	.01	.01	.01	3.	1.01	18.05	217	.02	.02	.00	.00	163.
1.01	5.45	69	.01	.01	.01	3.	1.01	18.10	218	.02	.02	.00	.00	149.
1.01	5.50	70	.01	.01	.01	3.	1.01	18.15	219	.02	.02	.00	.00	111.
1.01	5.55	71	.01	.01	.01	4.	1.01	18.20	220	.02	.02	.00	.00	79.
1.01	6.00	72	.01	.01	.01	4.	1.01	18.25	221	.02	.02	.00	.00	95.
1.01	6.05	73	.06	.03	.04	4.	1.01	18.30	222	.02	.02	.00	.00	43.
1.01	6.10	74	.06	.03	.04	6.	1.01	18.35	223	.02	.02	.00	.00	37.
1.01	6.15	75	.06	.03	.04	9.	1.01	18.40	224	.02	.02	.00	.00	31.
1.01	6.20	76	.06	.03	.03	13.	1.01	18.45	225	.02	.02	.00	.00	27.
1.01	6.25	77	.06	.03	.03	16.	1.01	18.50	226	.02	.02	.00	.00	23.
1.01	6.30	78	.06	.03	.03	18.	1.01	18.55	227	.02	.02	.00	.00	17.
1.01	6.35	79	.06	.03	.03	20.	1.01	19.00	228	.02	.02	.00	.00	17.
1.01	6.40	80	.06	.04	.03	21.	1.01	19.05	229	.02	.02	.00	.00	16.
1.01	6.45	81	.06	.04	.03	22.	1.01	19.10	230	.02	.02	.00	.00	15.
1.01	6.50	82	.06	.04	.03	23.	1.01	19.15	231	.02	.02	.00	.00	15.
1.01	6.55	83	.06	.04	.03	24.	1.01	19.20	232	.02	.02	.00	.00	15.
1.01	7.00	84	.06	.04	.02	25.	1.01	19.25	233	.02	.02	.00	.00	15.
1.01	7.05	85	.06	.04	.02	26.	1.01	19.30	234	.02	.02	.00	.00	15.
1.01	7.10	86	.06	.04	.02	27.	1.01	19.35	235	.02	.02	.00	.00	15.
1.01	7.15	87	.06	.04	.02	27.	1.01	19.40	236	.02	.02	.00	.00	15.
1.01	7.20	88	.06	.04	.02	28.	1.01	19.45	237	.02	.02	.00	.00	15.
1.01	7.25	89	.06	.04	.02	29.	1.01	19.50	238	.02	.02	.00	.00	15.
1.01	7.30	90	.06	.04	.02	29.	1.01	19.55	239	.02	.02	.00	.00	15.
1.01	7.35	91	.06	.05	.02	30.	1.01	20.00	240	.02	.02	.00	.00	15.
1.01	7.40	92	.06	.05	.02	30.	1.01	20.05	241	.02	.02	.00	.00	15.
1.01	7.45	93	.06	.05	.02	31.	1.01	20.10	242	.02	.02	.00	.00	15.
1.01	7.50	94	.06	.05	.02	31.	1.01	20.15	243	.02	.02	.00	.00	15.
1.01	7.55	95	.06	.05	.02	32.	1.01	20.20	244	.02	.02	.00	.00	15.
1.01	8.00	96	.06	.05	.02	32.	1.01	20.25	245	.02	.02	.00	.00	15.
1.01	8.05	97	.06	.05	.02	33.	1.01	20.30	246	.02	.02	.00	.00	15.
1.01	8.10	98	.06	.05	.02	33.	1.01	20.35	247	.02	.02	.00	.00	15.
1.01	8.15	99	.06	.05	.02	33.	1.01	20.40	248	.02	.02	.00	.00	15.
1.01	8.20	100	.06	.05	.01	34.	1.01	20.45	249	.02	.02	.00	.00	15.
1.01	8.25	101	.06	.05	.01	34.	1.01	20.50	250	.02	.02	.00	.00	15.
1.01	8.30	102	.06	.05	.01	34.	1.01	20.55	251	.02	.02	.00	.00	15.
1.01	8.35	103	.06	.05	.01	35.	1.01	21.00	252	.02	.02	.00	.00	15.
1.01	8.40	104	.06	.05	.01	35.	1.01	21.05	253	.02	.02	.00	.00	15.
1.01	8.45	105	.06	.05	.01	35.	1.01	21.10	254	.02	.02	.00	.00	15.
1.01	8.50	106	.06	.05	.01	36.	1.01	21.15	255	.02	.02	.00	.00	15.
1.01	8.55	107	.06	.05	.01	36.	1.01	21.20	256	.02	.02	.00	.00	15.
1.01	9.00	108	.06	.05	.01	36.	1.01	21.25	257	.02	.02	.00	.00	15.
1.01	9.05	109	.06	.05	.01	36.	1.01	21.30	258	.02	.02	.00	.00	15.
1.01	9.10	110	.06	.05	.01	37.	1.01	21.35	259	.02	.02	.00	.00	15.
1.01	9.15	111	.06	.05	.01	37.	1.01	21.40	260	.02	.02	.00	.00	15.
1.01	9.20	112	.06	.05	.01	37.	1.01	21.45	261	.02	.02	.00	.00	15.
1.01	9.25	113	.06	.05	.01	37.	1.01	21.50	262	.02	.02	.00	.00	15.
1.01	9.30	114	.06	.05	.01	37.	1.01	21.55	263	.02	.02	.00	.00	15.
1.01	9.35	115	.06	.05	.01	38.	1.01	22.00	264	.02	.02	.00	.00	15.
1.01	9.40	116	.06	.06	.01	38.	1.01	22.05	265	.02	.02	.00	.00	15.

Output	Varior	Lawler	MO	3	B8
252	253	254	255	256	257
258	259	260	261	262	263
264	265	266	267	268	269
270	271	272	273	274	275
276	277	278	279	280	281
282	283	284	285	286	287
288	289	290	291	292	293
294	295	296	297	298	299
300	301	302	303	304	305
306	307	308	309	310	311
312	313	314	315	316	317
318	319	320	321	322	323
324	325	326	327	328	329
330	331	332	333	334	335
336	337	338	339	340	341
342	343	344	345	346	347
348	349	350	351	352	353
354	355	356	357	358	359
360	361	362	363	364	365
366	367	368	369	370	371
372	373	374	375	376	377
378	379	380	381	382	383
384	385	386	387	388	389
390	391	392	393	394	395
396	397	398	399	400	401
402	403	404	405	406	407
408	409	410	411	412	413
414	415	416	417	418	419
420	421	422	423	424	425
426	427	428	429	430	431
432	433	434	435	436	437
438	439	440	441	442	443
444	445	446	447	448	449
450	451	452	453	454	455
456	457	458	459	460	461
462	463	464	465	466	467
468	469	470	471	472	473
474	475	476	477	478	479
480	481	482	483	484	485
486	487	488	489	490	491
492	493	494	495	496	497
498	499	500	501	502	503
504	505	506	507	508	509
510	511	512	513	514	515
516	517	518	519	520	521
522	523	524	525	526	527
528	529	530	531	532	533
534	535	536	537	538	539
540	541	542	543	544	545
546	547	548	549	550	551
552	553	554	555	556	557
558	559	560	561	562	563
564	565	566	567	568	569
570	571	572	573	574	575
576	577	578	579	580	581
582	583	584	585	586	587
588	589	590	591	592	593
594	595	596	597	598	599
600	601	602	603	604	605
606	607	608	609	610	611
612	613	614	615	616	617
618	619	620	621	622	623
624	625	626	627	628	629
630	631	632	633	634	635
636	637	638	639	640	641
642	643	644	645	646	647

Output Summary
Various PMF Events
Lawless Lake Dam
MO 31717
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PEAK FLOW AND STORAGE LENGTH OF PERIOD SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN RATIO	RATIO 1	RATIO 2
HYDROGRAPH AT SAFETY					
		.09	1	.463	.926
		.23	1	13.109	26.211
ROUTED TO DAM		.09	1	.464	.935
		.23	1	13.151	26.471

SUMMARY OF DAM SAFETY ANALYSIS

PLAN	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	STORAGE	795.90	795.90	796.90
	OUTFLOW	40.	40.	48.
		0.	0.	100.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	799.60	.70	50.	464.	2.92	15.83	0.00
1.00	799.99	1.09	51.	935.	5.83	15.83	0.00

Output Summary
 Various PMF Events
 Lawless Lake Dam
 MO 31717
 B9

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

STATION	AREA	PLAN RATIO 1	RATIO 2	RATIOS APPLIED TO FLOWS				
				RATIO 3	RATIO 4	RATIO 5		
			.12	.13	.14	.15	.16	
STATION 1	0.231	111	120	130	139	148		
		3.1531	3.4111	3.6711	3.9311	4.1911		
STATION 2	0.09	80	90	100	108	116		
	0.231	2.2511	2.5611	2.8211	3.0511	3.3011		

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	ELEVATION STORAGE OUTFLOW	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM	DURATION OVER TOP HOURS	MAXIMUM OUTFLOW CFS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
		795.90	795.90	798.90				
		40	40	48				
		0	0	100				
RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS	
.12	798.79	0.00	48	80	0.00	16.00	0.00	
.13	798.84	0.00	48	90	0.00	16.00	0.00	
.14	798.90	0.00	48	100	0.00	16.00	0.00	
.15	798.95	.35	48	108	.25	16.00	0.00	
.16	799.00	.10	48	116	.33	16.00	0.00	

Output Summary
 Various PMF Events
 Lawless Lake Dam
 MO 31717
 B10

LAWLASS LAKE DAM 03/17. IRON COUNTY, MISSOURI
WOODWARD-CLYDE-CONSULTANTS, HOUSTON-308-00C22-47100
PROBABILISTIC FLOOD -100 YEAR

Input Data
1% Probability Event
Lawless Lake Dam
MO 31717
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Input Data
 1% Probability Event
 Lawless Lake Dam
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32	95	770.	780.	790.	795.9	798.9	800.	810.	820.	830.	840.
33	98	795.9									
34	99	80	798.9	2.8	1.5						
35	99	81	...	94.	177.	293.	300.	303.	306.	310.	312.98
36	99	84798.93	799.13	799.19	799.78	800.46	802.	803.	804.	805.	805.68
37	99	8	...	99							

Output Summary
1% Probability Event
Lawless Lake Dam
MO 31717
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Output Summary
 1% Probability Event
 Lawless Lake Dam
 MO 31717
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LOSS DATA
 LQPT STRK RTOL ERAIN STRKS RTIOK STYTL CNSTL ALSMX RTIAP
 0.00 0.00 1.00 0.00 0.00 1.00 -1.00 -65.00 0.00 0.00
 CURVE NO = -65.00 4ETRESS = -1.00 EFFECT CM = 65.00

UNIT HYDROGRAPH DATA
 TC= 0.30 LAG= .25

RECESSION DATA
 SYRTJ= -1.00 QRCNM= -.05 RTIOK= 5.00

UNIT HYDROGRAPH 17 ENJ OF PERIOD ORIGINATES. TC= 0.00 HOURS. LAG= .25 VOL= 1.00
 26. 144. 112. 67. 42. 27. 17. 11.

HR	NO	PERIOD	RAIN	EXCS	LOSS	COMP	END-OF-PERIOD FLOW	HR	NO	PERIOD	RAIN	EXCS	LOSS	COMP
1.01	05	1	.01	0.00	.01	0.	1.01 12.30	150	.14	.10	.04	.04	.04	125.
1.01	10	2	.01	0.00	.01	0.	1.01 12.35	151	.06	.04	.02	.02	.02	105.
1.01	15	3	.01	0.00	.01	0.	1.01 12.40	152	.06	.04	.02	.02	.02	84.
1.01	20	4	.01	0.00	.01	0.	1.01 12.45	153	.06	.04	.02	.02	.02	62.
1.01	25	5	.01	0.00	.01	0.	1.01 12.50	154	.06	.04	.02	.02	.02	54.
1.01	30	6	.01	0.00	.01	0.	1.01 12.55	155	.06	.04	.02	.02	.02	44.
1.01	35	7	.01	0.00	.01	0.	1.01 13.00	156	.06	.04	.02	.02	.02	38.
1.01	40	8	.01	0.00	.01	0.	1.01 13.05	157	.03	.02	.01	.01	.01	34.
1.01	45	9	.01	0.00	.01	0.	1.01 13.10	158	.03	.02	.01	.01	.01	30.
1.01	50	10	.01	0.00	.01	0.	1.01 13.15	159	.03	.02	.01	.01	.01	26.
1.01	55	11	.01	0.00	.01	0.	1.01 13.20	160	.03	.02	.01	.01	.01	23.
1.01	1.00	12	.01	0.00	.01	0.	1.01 13.25	161	.03	.02	.01	.01	.01	20.
1.01	1.05	13	.01	0.00	.01	0.	1.01 13.30	162	.03	.02	.01	.01	.01	19.
1.01	1.10	14	.01	0.00	.01	0.	1.01 13.35	163	.02	.02	.01	.01	.01	18.
1.01	1.15	15	.01	0.00	.01	0.	1.01 13.40	164	.02	.02	.01	.01	.01	17.
1.01	1.20	16	.01	0.00	.01	0.	1.01 13.45	165	.02	.02	.01	.01	.01	16.
1.01	1.25	17	.01	0.00	.01	0.	1.01 13.50	166	.02	.02	.01	.01	.01	15.
1.01	1.30	18	.01	0.00	.01	0.	1.01 13.55	167	.02	.02	.01	.01	.01	14.
1.01	1.35	19	.01	0.00	.01	0.	1.01 14.00	168	.02	.02	.01	.01	.01	13.
1.01	1.40	20	.01	0.00	.01	0.	1.01 14.05	169	.02	.02	.01	.01	.01	13.
1.01	1.45	21	.01	0.03	.01	0.	1.01 14.10	170	.02	.02	.01	.01	.01	13.
1.01	1.50	22	.01	0.00	.01	0.	1.01 14.15	171	.02	.02	.01	.01	.01	13.
1.01	1.55	23	.01	0.00	.01	0.	1.01 14.20	172	.02	.02	.01	.01	.01	13.
1.01	2.00	24	.01	0.00	.01	0.	1.01 14.25	173	.02	.02	.01	.01	.01	13.
1.01	2.05	25	.01	0.00	.01	0.	1.01 14.30	174	.02	.02	.01	.01	.01	13.
1.01	2.10	26	.01	0.00	.01	0.	1.01 14.35	175	.02	.02	.01	.01	.01	13.
1.01	2.15	27	.01	0.00	.01	0.	1.01 14.40	176	.02	.02	.01	.01	.01	13.
1.01	2.20	28	.01	0.00	.01	0.	1.01 14.45	177	.02	.02	.01	.01	.01	13.
1.01	2.25	29	.01	0.00	.01	0.	1.01 14.50	178	.02	.02	.01	.01	.01	13.
1.01	2.30	30	.01	0.00	.01	0.	1.01 14.55	179	.02	.02	.01	.01	.01	13.
1.01	2.35	31	.01	0.00	.01	0.	1.01 15.00	180	.02	.02	.01	.01	.01	13.
1.01	2.40	32	.01	0.00	.01	0.	1.01 15.05	181	.01	.01	.00	.00	.00	12.
1.01	2.45	33	.01	0.03	.01	0.	1.01 15.10	182	.01	.01	.00	.00	.00	12.
1.01	2.50	34	.01	0.00	.01	0.	1.01 15.15	183	.01	.01	.00	.00	.00	11.
1.01	2.55	35	.01	0.03	.01	0.	1.01 15.20	184	.01	.01	.00	.00	.00	10.
1.01	3.00	36	.01	0.00	.01	0.	1.01 15.25	185	.01	.01	.00	.00	.00	9.
1.01	3.05	37	.01	0.00	.01	0.	1.01 15.30	186	.01	.01	.00	.00	.00	8.
1.01	3.10	38	.01	0.00	.01	0.	1.01 15.35	187	.01	.01	.00	.00	.00	8.
1.01	3.15	39	.01	0.00	.01	0.	1.01 15.40	188	.01	.01	.00	.00	.00	8.
1.01	3.20	40	.01	0.00	.01	0.	1.01 15.45	189	.01	.01	.00	.00	.00	7.
1.01	3.25	41	.01	0.00	.01	0.	1.01 15.50	190	.01	.01	.00	.00	.00	7.
1.01	3.30	42	.01	0.00	.01	0.	1.01 15.55	191	.01	.01	.00	.00	.00	7.
1.01	3.35	43	.01	0.00	.01	0.	1.01 16.00	192	.01	.01	.00	.00	.00	7.

Output Summary
1% Probability Event
Lawless Lake Dam
MO 31717
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1.01	3.25	36	.01	0.00	.01	0.	1.01	15.25	185	.01	.01	.00	.00	.00	.00
1.01	3.30	37	.01	0.00	.01	0.	1.01	15.30	186	.01	.01	.00	.00	.00	.00
1.01	3.35	38	.01	0.00	.01	0.	1.01	15.35	187	.01	.01	.00	.00	.00	.00
1.01	3.40	39	.01	0.00	.01	0.	1.01	15.40	188	.01	.01	.00	.00	.00	.00
1.01	3.45	40	.01	0.00	.01	0.	1.01	15.45	189	.01	.01	.00	.00	.00	.00
1.01	3.50	41	.01	0.00	.01	0.	1.01	15.50	190	.01	.01	.00	.00	.00	.00
1.01	3.55	42	.01	0.00	.01	0.	1.01	15.55	191	.01	.01	.00	.00	.00	.00
1.01	3.60	43	.01	0.00	.01	0.	1.01	16.00	192	.01	.01	.00	.00	.00	.00
1.01	3.65	44	.01	0.00	.01	0.	1.01	16.05	193	.01	.01	.00	.00	.00	.00
1.01	3.70	45	.01	0.00	.01	0.	1.01	16.10	194	.01	.01	.00	.00	.00	.00
1.01	3.75	46	.01	0.00	.01	0.	1.01	16.15	195	.01	.01	.00	.00	.00	.00
1.01	3.80	47	.01	0.00	.01	0.	1.01	16.20	196	.01	.01	.00	.00	.00	.00
1.01	3.85	48	.01	0.00	.01	0.	1.01	16.25	197	.01	.01	.00	.00	.00	.00
1.01	3.90	49	.01	0.00	.01	0.	1.01	16.30	198	.01	.01	.00	.00	.00	.00
1.01	3.95	50	.01	0.00	.01	0.	1.01	16.35	199	.01	.01	.00	.00	.00	.00
1.01	4.00	51	.01	0.00	.01	0.	1.01	16.40	200	.01	.01	.00	.00	.00	.00
1.01	4.05	52	.01	0.00	.01	0.	1.01	16.45	201	.01	.01	.00	.00	.00	.00
1.01	4.10	53	.01	0.00	.01	0.	1.01	16.50	202	.01	.01	.00	.00	.00	.00
1.01	4.15	54	.01	0.00	.01	0.	1.01	16.55	203	.01	.01	.00	.00	.00	.00
1.01	4.20	55	.01	0.00	.01	0.	1.01	17.00	204	.01	.01	.00	.00	.00	.00
1.01	4.25	56	.01	0.00	.01	0.	1.01	17.05	205	.01	.01	.00	.00	.00	.00
1.01	4.30	57	.01	0.00	.01	0.	1.01	17.10	206	.01	.01	.00	.00	.00	.00
1.01	4.35	58	.01	0.00	.01	0.	1.01	17.15	207	.01	.01	.00	.00	.00	.00
1.01	4.40	59	.01	0.00	.01	0.	1.01	17.20	208	.01	.01	.00	.00	.00	.00
1.01	4.45	60	.01	0.00	.01	0.	1.01	17.25	209	.01	.01	.00	.00	.00	.00
1.01	4.50	61	.01	0.00	.01	0.	1.01	17.30	210	.01	.01	.00	.00	.00	.00
1.01	4.55	62	.01	0.00	.01	0.	1.01	17.35	211	.01	.01	.00	.00	.00	.00
1.01	4.60	63	.01	0.00	.01	0.	1.01	17.40	212	.01	.01	.00	.00	.00	.00
1.01	4.65	64	.01	0.00	.01	0.	1.01	17.45	213	.01	.01	.00	.00	.00	.00
1.01	4.70	65	.01	0.00	.01	0.	1.01	17.50	214	.01	.01	.00	.00	.00	.00
1.01	4.75	66	.01	0.00	.01	0.	1.01	17.55	215	.01	.01	.00	.00	.00	.00
1.01	4.80	67	.01	0.00	.01	0.	1.01	18.00	216	.01	.01	.00	.00	.00	.00
1.01	4.85	68	.01	0.00	.01	0.	1.01	18.05	217	.01	.01	.00	.00	.00	.00
1.01	4.90	69	.01	0.00	.01	0.	1.01	18.10	218	.01	.01	.00	.00	.00	.00
1.01	4.95	70	.01	0.00	.01	0.	1.01	18.15	219	.01	.01	.00	.00	.00	.00
1.01	5.00	71	.01	0.00	.01	0.	1.01	18.20	220	.01	.01	.00	.00	.00	.00
1.01	5.05	72	.01	0.00	.01	0.	1.01	18.25	221	.01	.01	.00	.00	.00	.00
1.01	5.10	73	.01	0.00	.01	0.	1.01	18.30	222	.01	.01	.00	.00	.00	.00
1.01	5.15	74	.01	0.00	.01	0.	1.01	18.35	223	.01	.01	.00	.00	.00	.00
1.01	5.20	75	.01	0.00	.01	0.	1.01	18.40	224	.01	.01	.00	.00	.00	.00
1.01	5.25	76	.01	0.00	.01	0.	1.01	18.45	225	.01	.01	.00	.00	.00	.00
1.01	5.30	77	.01	0.00	.01	0.	1.01	18.50	226	.01	.01	.00	.00	.00	.00
1.01	5.35	78	.01	0.00	.01	0.	1.01	18.55	227	.01	.01	.00	.00	.00	.00
1.01	5.40	79	.01	0.00	.01	0.	1.01	19.00	228	.01	.01	.00	.00	.00	.00
1.01	5.45	80	.01	0.00	.01	0.	1.01	19.05	229	.01	.01	.00	.00	.00	.00
1.01	5.50	81	.01	0.00	.01	0.	1.01	19.10	230	.01	.01	.00	.00	.00	.00
1.01	5.55	82	.01	0.00	.01	0.	1.01	19.15	231	.01	.01	.00	.00	.00	.00
1.01	5.60	83	.01	0.00	.01	0.	1.01	19.20	232	.01	.01	.00	.00	.00	.00
1.01	5.65	84	.01	0.00	.01	0.	1.01	19.25	233	.01	.01	.00	.00	.00	.00
1.01	5.70	85	.01	0.00	.01	0.	1.01	19.30	234	.01	.01	.00	.00	.00	.00
1.01	5.75	86	.01	0.00	.01	0.	1.01	19.35	235	.01	.01	.00	.00	.00	.00
1.01	5.80	87	.01	0.00	.01	0.	1.01	19.40	236	.01	.01	.00	.00	.00	.00
1.01	5.85	88	.01	0.00	.01	0.	1.01	19.45	237	.01	.01	.00	.00	.00	.00
1.01	5.90	89	.01	0.00	.01	0.	1.01	19.50	238	.01	.01	.00	.00	.00	.00
1.01	5.95	90	.01	0.00	.01	0.	1.01	19.55	239	.01	.01	.00	.00	.00	.00
1.01	6.00	91	.01	0.00	.01	0.	1.01	20.00	240	.01	.01	.00	.00	.00	.00
1.01	6.05	92	.01	0.00	.01	0.	1.01	20.05	241	.01	.01	.00	.00	.00	.00
1.01	6.10	93	.01	0.00	.01	0.	1.01	20.10	242	.01	.01	.00	.00	.00	.00
1.01	6.15	94	.01	0.00	.01	0.	1.01	20.15	243	.01	.01	.00	.00	.00	.00
1.01	6.20	95	.01	0.00	.01	0.	1.01	20.20	244	.01	.01	.00	.00	.00	.00
1.01	6.25	96	.01	0.00	.01	0.	1.01	20.25	245	.01	.01	.00	.00	.00	.00
1.01	6.30	97	.01	0.00	.01	0.	1.01	20.30	246	.01	.01	.00	.00	.00	.00
1.01	6.35	98	.01	0.00	.01	0.	1.01	20.35	247	.01	.01	.00	.00	.00	.00
1.01	6.40	99	.01	0.00	.01	0.	1.01	20.40	248	.01	.01	.00	.00	.00	.00
1.01	6.45	100	.01	0.00	.01	0.	1.01	20.45	249	.01	.01	.00	.00	.00	.00

Output Summary
 1% Probability Event
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 MO 31717
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1.01	7.55	95	.01	0.00	.01	0.	1.01	20.20	244	.01	.01	.00	4.
1.01	7.00	96	.01	0.00	.01	0.	1.01	20.25	245	.01	.01	.00	4.
1.01	6.95	97	.01	0.00	.01	0.	1.01	20.30	246	.01	.01	.00	4.
1.01	6.10	98	.01	0.00	.01	0.	1.01	20.35	247	.01	.01	.00	4.
1.01	6.15	99	.01	0.00	.01	0.	1.01	20.40	248	.01	.01	.00	4.
1.01	6.20	100	.01	0.00	.01	0.	1.01	20.45	249	.01	.01	.00	4.
1.01	6.25	101	.01	0.00	.01	0.	1.01	20.50	250	.01	.01	.00	4.
1.01	6.30	102	.01	0.00	.01	0.	1.01	20.55	251	.01	.01	.00	4.
1.01	6.35	103	.01	0.00	.01	0.	1.01	21.00	252	.01	.01	.00	4.
1.01	6.40	104	.01	0.00	.01	0.	1.01	21.05	253	.01	.01	.00	4.
1.01	6.45	105	.01	0.00	.01	0.	1.01	21.10	254	.01	.01	.00	4.
1.01	6.50	106	.01	0.00	.01	0.	1.01	21.15	255	.01	.01	.00	4.
1.01	6.55	107	.01	0.00	.01	0.	1.01	21.20	256	.01	.01	.00	4.
1.01	9.00	108	.01	0.00	.01	0.	1.01	21.25	257	.01	.01	.00	4.
1.01	9.05	109	.02	0.00	.02	0.	1.01	21.30	258	.01	.01	.00	4.
1.01	9.10	110	.02	0.00	.02	0.	1.01	21.35	259	.01	.01	.00	4.
1.01	9.15	111	.02	.00	.02	0.	1.01	21.40	260	.01	.01	.00	4.
1.01	9.20	112	.02	.00	.02	0.	1.01	21.45	261	.01	.01	.00	4.
1.01	9.25	113	.02	.00	.02	0.	1.01	21.50	262	.01	.01	.00	4.
1.01	9.30	114	.02	.00	.02	0.	1.01	21.55	263	.01	.01	.00	4.
1.01	9.35	115	.02	.00	.02	0.	1.01	22.00	264	.01	.01	.00	4.
1.01	9.40	116	.02	.00	.02	0.	1.01	22.05	265	.01	.01	.00	4.
1.01	9.45	117	.02	.00	.02	0.	1.01	22.10	266	.01	.01	.00	4.
1.01	9.50	118	.02	.00	.02	1.	1.01	22.15	267	.01	.01	.00	4.
1.01	9.55	119	.02	.00	.02	1.	1.01	22.20	268	.01	.01	.00	4.
1.01	10.00	120	.02	.00	.02	1.	1.01	22.25	269	.01	.01	.00	4.
1.01	10.05	121	.02	.00	.02	1.	1.01	22.30	270	.01	.01	.00	4.
1.01	10.10	122	.02	.00	.02	1.	1.01	22.35	271	.01	.01	.00	4.
1.01	10.15	123	.02	.00	.02	1.	1.01	22.40	272	.01	.01	.00	4.
1.01	10.20	124	.02	.00	.02	1.	1.01	22.45	273	.01	.01	.00	4.
1.01	10.25	125	.02	.00	.02	2.	1.01	22.50	274	.01	.01	.00	4.
1.01	10.30	126	.02	.00	.02	2.	1.01	22.55	275	.01	.01	.00	4.
1.01	10.35	127	.03	.00	.03	2.	1.01	23.00	276	.01	.01	.00	4.
1.01	10.40	128	.03	.00	.03	2.	1.01	23.05	277	.01	.01	.00	4.
1.01	10.45	129	.03	.00	.03	2.	1.01	23.10	278	.01	.01	.00	4.
1.01	10.50	130	.03	.01	.03	3.	1.01	23.15	279	.01	.01	.00	4.
1.01	10.55	131	.03	.01	.03	3.	1.01	23.20	280	.01	.01	.00	4.
1.01	11.00	132	.03	.01	.03	3.	1.01	23.25	281	.01	.01	.00	4.
1.01	11.05	133	.06	.01	.05	4.	1.01	23.30	282	.01	.01	.00	4.
1.01	11.10	134	.06	.01	.05	4.	1.01	23.35	283	.01	.01	.00	4.
1.01	11.15	135	.06	.01	.05	5.	1.01	23.40	284	.01	.01	.00	4.
1.01	11.20	136	.06	.01	.04	6.	1.01	23.45	285	.01	.01	.00	4.
1.01	11.25	137	.06	.01	.04	7.	1.01	23.50	286	.01	.01	.00	4.
1.01	11.30	138	.06	.02	.04	8.	1.01	23.55	287	.01	.01	.00	4.
1.01	11.35	139	.14	.04	.10	10.	1.02	0.00	288	.01	.01	.00	4.
1.01	11.40	140	.14	.04	.10	13.	1.02	.05	289	0.00	0.00	0.00	4.
1.01	11.45	141	.14	.05	.09	17.	1.02	.10	290	0.00	0.00	0.00	3.
1.01	11.50	142	.27	.10	.16	23.	1.02	.15	291	0.00	0.00	0.00	3.
1.01	11.55	143	.27	.11	.15	33.	1.02	.20	292	0.00	0.00	0.00	2.
1.01	12.00	144	.55	.27	.28	48.	1.02	.25	293	0.00	0.00	0.00	2.
1.01	12.05	145	.82	.46	.35	79.	1.02	.30	294	0.00	0.00	0.00	2.
1.01	12.10	146	.30	.24	.14	122.	1.02	.35	295	0.00	0.00	0.00	1.
1.01	12.15	147	.27	.17	.09	156.	1.02	.40	296	0.00	0.00	0.00	1.
1.01	12.20	148	.16	.09	.05	165.	1.02	.45	297	0.00	0.00	0.00	1.
1.01	12.25	149	.14	.09	.05	150.	1.02	.50	298	0.00	0.00	0.00	1.
1.01	12.25	149	.14	.09	.05	150.	1.02	.55	299	0.00	0.00	0.00	1.
SUM										7.39	3.41	3.98	2987.
										148.11	67.91	101.10	67.591

RUNOFF SUMMARY. AVERAGE FLOW IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES(SQUARE KILOMETERS)

HYDROGRAPH AT INFLOW	PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
.....	155.	27.	8.	8.	.09
.....	4.6611	.7811	.2311	.2311	.231
ROUTED TO DAM	60.	19.	7.	6.	.09
.....	1.6911	.5411	.1911	.1811	.231

SUMMARY OF DAM SAFETY ANALYSES

.....	ELEVATION	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM			
.....	STORAGE	795.90	795.90	798.90			
.....	OUTFLOW	40.	40.	48.			
.....		0.	0.	100.			
RATIO	MAXIMUM	MAXIMUM	MAXIMUM	DURATION	TIME OF	TIME OF	
OF	RESERVOIR	DEPTH	STORAGE	OVER TOP	MAX OUTFLOW	FAILURE	
PNF	W.S.ELEV	OVER DAM	AC-FT	HOURS	HOURS	HOURS	
0.00	798.66	0.00	47.	0.00	12.83	0.00	

Output Summary
1% Probability Event
Lawless Lake Dam
MO 31717
B17